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Compressed Air

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. VII. NEW YORK, JANUARY, 1903. No. 11.

"COMPRESSED AIR INFORMATION"

OR

A CYCLOPEDIA CONTAINING PRACTICAL PAPERS ON THE PRODUCTION, TRANSMISSION AND USE OF COMPRESSED AIR.

EDITED BY

W. L. SAUNDERS,

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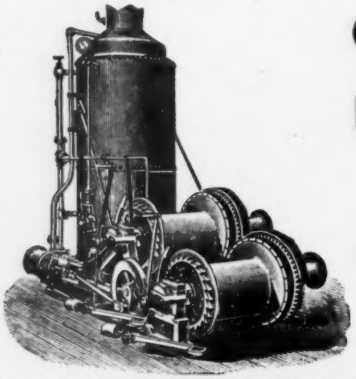

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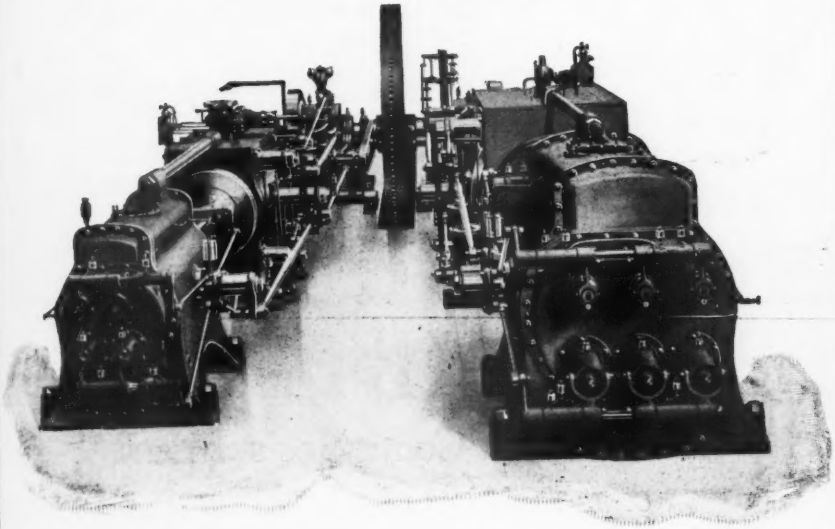

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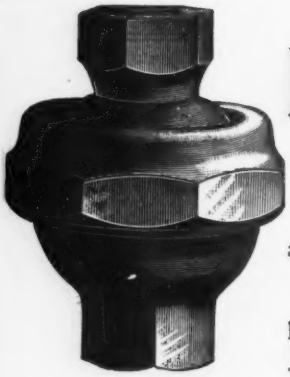

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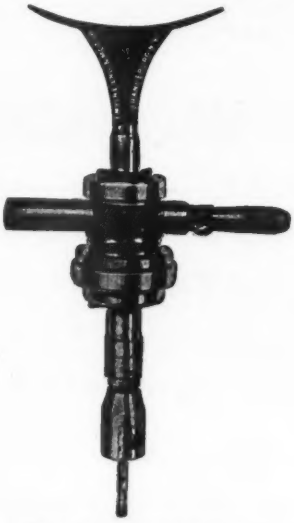

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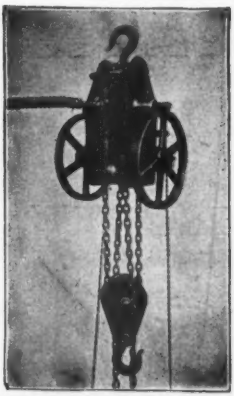

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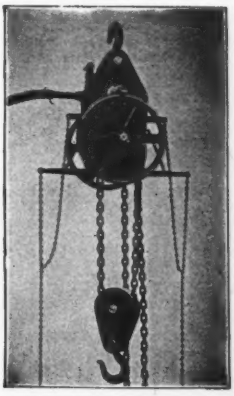

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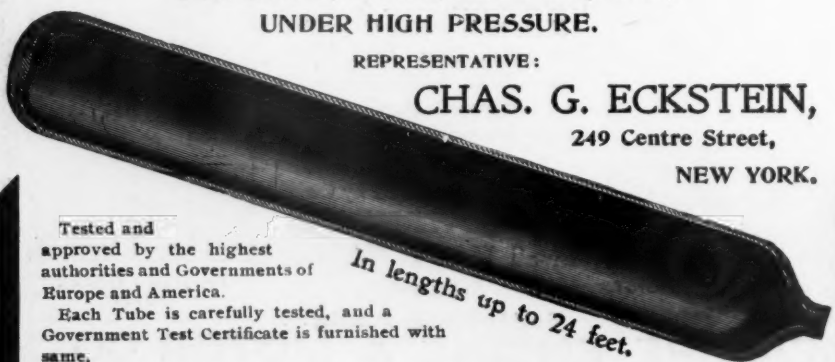

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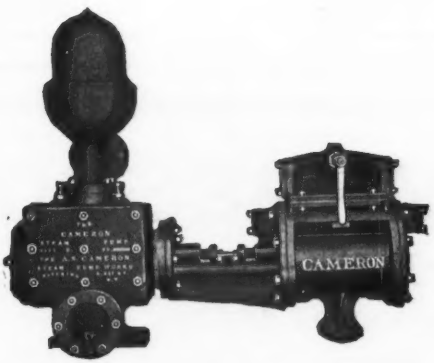

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VOL. VII. JANUARY, 1903. NO. 11

Changes in "Compressed Air."

Since its first issue and until recently the cover of each number of COMPRESSED AIR has had a frontispiece illustrating some new application of compressed air or referring to an article in the body of the magazine. This undoubtedly added to the appearance of the cover and to that extent was an excellent idea, but the arrangement always involved the loss of the illustration in question when the numbers were bound up, unless the cover was included. Binding covers and advertising with the text is an unsatisfactory arrangement at best and the result has been that the frontispiece was usually lost.

In view of this it has been decided hereafter to omit the frontispiece and use the cover simply as a protection, and beginning with our March issue this space will be available for advertising. We consider this an exceedingly desirable position because the page is small so that the one or more advertisements which may appear on the front cover will stand out with unusual prominence and will not be more or less lost as is the case with papers having larger advertising pages.

Charges for the page in whole or in part for one or more issues will be furnished on request.

We wish to call attention to the cover of this issue where we advertise "Compressed Air Information, or a Cyclopedia Containing Practical Papers on the Production, Transmission and Use of Compressed Air." It is hoped and expected that by the time the present number of COMPRESSED AIR reaches you the book will be completed and ready for delivery.

As already stated the publication came about through the frequent inquiries for copies of papers which appeared in COMPRESSED AIR during the first five years of its existence and owing to the supply of these early papers being entirely exhausted and the demand continuing.

No attempt has been made to introduce new matter but the various papers, editorials and notes have been arranged in their logical order of Production, Transmission and Use, and all are indexed so that the material is available for ready reference. As the book stands it contains nearly every practical paper on Compressed Air, either in full or in abstract, which appeared in print during the five years which it covers. There are seventy-five tables and nearly five hundred illustrations and a full list of American patents bearing on compressed air and its applications. We believe the book to be one of the most practical productions which has appeared in the field to which it is devoted. We recommend it to our recent subscribers as it will enable them to have a complete file of COMPRESSED AIR.

Electric Power for General Purposes in Mining and Milling.*

This paper deals with results obtained in Amador county, Cal., using electricity at $6.50 per horse power per month, furnished by the Standard Electric Co. of California, generated at their plant at Electra, Amador county, from which about 14,000 H. P., of alternating current, is distributed through the central portion of the State. The transmission line along the mother lode from Angels Camp, Calaveras county, to the Fremont mine. 1½ mile north of Amador City, carries a 10,000 volt current, which is transferred at each mine to 550 or 600 volts for power purposes and 125 volts for lighting purposes. At the Fremont mine the superintendent. C. E. Purrington, has installed a 20½x24 duplex Ingersoll-Sergeant single stage compressor, capacity 1.700 cubic feet free air per minute. The compressor is operated by a 300 H. P. general electric motor. The air is used for all purposes, hoisting, drilling and pumping water. The plant is only recently installed, so figures cannot be given accurately, but the superintendent informs me it is giving entire satisfaction. This plant is equipped with six air receivers of 1.500 cubic feet capacity and several hundred feet 6-inch pipe for storage, besides the three steam boilers in which the air used (by hoisting engine) is reheated. This compressor has a unique unloader, being an automatically regulated valve in the pipe through which the compressor takes air, which valve is closed when the air pressure reaches any particular point it is set at. Of course, if the compressor sucks no air it pumps none, or practically so.

The Keystone Co. at Amador City saved $150 per month using electricity at $6.50 per horse power month, compared with water used under 185 feet fall at 20 cents per inch, formerly used in running this 40-stamp mill. They are now using compressed air for hoisting and drilling, the compressor being run by a 300 H. P. general electric motor with a 550 volt current. This plant is only recently installed. At the Kennedy mine a change from pine wood at $6 per cord in the furnace to crude oil at $1.50 per barrel was made. They found that $17 worth of oil did the same work as $24 worth of wood.

The article deals largely in compressed air plants, for with the exceptions when electricity is applied direct to mill rock breaker, blowers and pumps, compressed air, apparently, is the only resort, which accounts for its prominence in this paper, and as most mines art equipped with steam engines it is very easy to change from steam to air, as well as making it possible to fall back on steam in emergencies. As to electricity applied directly: Through the kindness of C. R. Downs, superintendent, and J. F. Phipps, assistant superintendent of the Bunker Hill mine at Amador City, Cal., I am informed that it costs them just one-half as much to run a No. 10 Buffalo forge blower by electric motor as by an upright steam engine, and much less care and repairs. The blower runs 1,700 revolutions per minute, blowing 4,000 cubic feet of air per minute through 2,000 feet of 11-inch pipe at a cost for power of $1.06 per day. This blower is run by a 10 H. P. general electric induction motor, consuming 5 H. P. per day; using steam it costs $2.12 per day. Here they also have a 12x14 Ingersoll-Sergeant single stage compressor running 160 revolutions per minute belted direct to a 50 H. P. general electric motor, using air for drilling and pumping. Until recently all the pumping was done by steam at 100 pounds pressure, and I am informed that they see no difference in cost of pumping by air or steam; it is about equal, with the advantage of having the air to use for drilling when needed. However, I believe from my experience at the South Spring Hill that if the steam cylinder end of the pumps were large enough diameter to use at forty pounds pressure and keep up to speed, there would be a balance in favor of air against steam. They are paying $6.50 per H. P. month for electricity and $6 for first-class pine wood in the furnace. This was proven very satisfactorily at the South Spring Hill where the pump running by compressed air was especially designed to work on air at forty-five pounds pressure, raising the water 725 feet vertically in one lift, the back pressure of the water at the pump being about 345 pounds to the square inch. This pump worked cheaper on air than it would by steam. Leakage and extraordinary heating of the air from com-

* Read by John B. Tregloan, Amador City, Cal., before the annual meeting California Miners' Association, San Francisco, Nov. 17, 18, 19, 1902.

pression make it advisable to use low pressure air whenever possible.

At the Oneida mine electricity is applied direct, a general electric 100 H. P. motor being geared directly to a Dow duplex plunger pump. This pump raises 200 gallons of water per minute, about 19 miners' inches of water, 1300 feet vertically in one lift through a 6-inch pipe for four and one-half hours daily at a cost of $3.40 per day for power; at $6.50 per H. P. month 100 H. P. of electricity is used; the actual weight of water raised 1300 feet represents 65 H. P., so that there is a loss of only 35 H. P., or 35 per cent. in radiation on line from the transformer to the motor in the mine, friction in motor, pump and pipe line, giving an absolute efficiency of 65 per cent., which compared with steam or air is about three or four times as efficient, taking into consideration the amount of energy purchased.

W. R. Thomas of the Central Eureka informs us that it costs about one-half to run their blower by electricity as it formerly did by water at 20 cents per inch. When the water head is 500 feet or so I believe it to be about a standoff with electricity at $6.50 per H. P. month and water at 20 cents per inch for power purchased, with the advantage in favor of electricity by eliminating long and expensive ditch and pipe lines, with their constant repair, maintenance and delays due to breakage.

It is not necessary to cite other mines using electricity direct regarding its efficiency, and I desire to devote the remainder of this paper to the use of electricity for hoisting purposes, through the medium of compressed air. However, it seems very strange that a proper understanding cannot be had as to the feasibility of electricity applied direct to hoisting machinery.

The first essential to every compressed air plant is ample storage, so that a minimum size compressor can be used, running comparatively slow, and maintain the working pressure as nearly constant as possible. Air once stored can be used today or next week if properly stored. As to leakage, let me call your attention to this fact: At sixty pounds pressure air will travel through a pin hole at the rate of 600 feet per second, or 36,000 feet per minute, nearly 7 miles per minute, so however small the hole is the volume is large where a steady stream is blowing away. The same rule applies to the blowoff, so use an unloader of some description, preferably one that holds the outlet valves open, allowing the compressor to be in absolute equilibrium, forcing air into the receiver from one side of the piston and drawing it from the receiver on the other, and vice versa on the return stroke.

As to two or more stage compression I desire to call your attention. It is the ideal way to compress air, but so-called two-stage compressors are a farce, unless the intercooler is of sufficient size and proper design to return the air to something near the atmospheric temperature while it is passing from the low to high pressure cylinders. The term two-stage is used a great deal to sell inefficient compressors.

It takes power to run a compressor 60, 75 or 150 revolutions per minute even if it is unloaded, so plan the size of compressor and storage so that it runs unloaded as seldom as possible only in emergencies of idleness for comparatively long periods of the machinery using air. It is no more necessary to have the compressor running unloaded most of the time than it is to have steam blowing off continually because there is a blowoff valve on the boiler. With an induction motor and the alternating type of current used in this country it is not possible to start and stop the compressor to avoid blowing away air, so that must be accomplished by proper storage, unloaders, and more important than anything else, a proper size compressor, neither too large nor too small, so that the aggregate amount of air used in twenty-four hours will be furnished by the compressor running at a speed not to exceed 200 feet of piston speed per minute with the stroke at least double the diameter of the cylinder, for economical results. Heavy flywheels are most essential on a compressor than on a rock breaker, although generally not so considered, to prevent any jerking on the rope transmission or belt. In a 10-inch diameter compressor, at the end of each stroke the pressure changes when pumping against 100 pounds pressure from a hold back of 7,854 pounds to a shove ahead of the same amount, and the air left there due to clearance runs the motor for an instant. A total change in tension on the belt or rope of 15,708 pounds, or nearly eight tons, a heavy fly is required to steady this motion, or it

will jerk the life out of the belt or rope in a short time, as well as cause slipping. Avoid countershafts by a large diameter heavy rim flywheel on the compressor and avoid a tightener on belt driven compressors which takes power to run it 800 or 1,000 revolutions per minute, by placing the motor far enough from the compressor, using a wide belt, so that the weight of the belt, with the slack side on top, will be sufficient to prevent slipping, which is another item of loss.

Now as to the efficiency of compressed air for hoisting engines, how can one expect air to be thoroughly satisfactory when the largest portion of power goes up the exhaust pipe, as well now and then it is all escaping through the blowoff on the receiver. I mention this because I have seen several plants doing this very thing and those in charge complaining about their compressor, or the electric motor, or some other reason, whereas the compressor is all right and a good, willing friend, likewise the electric motor, but the type of hoist and the storage and other things arranged by the superintendent himself are the only faulty things about the plant. Electricity and compressed air are a comparatively recent factor with which all miners must sooner or later familiarize themselves with, and when they meet this new factor with intelligence it will be as simple as hand drilling now is to the average miner. What would a superintendent say to his engineer if he continually had steam blowing off, or what would the board of directors say if there was a continual stream of water running over the waste gate of the reservoir? Yet just such extravagance has been and in some cases is being practiced with compressed air. Treat it as economically and intelligently as you would water power, wood, fuel oil, and with the electric current at not over $6.50 per horse power month it will be your best friend.

Receivers should be close to the compressors, and if possible, where the air is used for general purposes, run the air through an old boiler, submerged in water, which will compel the air, by cooling it, to drop what water is in it immediately and not drop it in the pipe line going down the shaft, so that it will not scour the pump cylinders and machine cylinders, as well as to a great degree prevent freezing at the exhaust, a common inconvenience. An old crosscut underground bulkheaded with concrete makes an efficient and at the same time large and cheap storage. Large piping and the absence of 90° elbows are very essential for economy. So much for the air plant; now for the hoisting engine itself.

Use double compound tandem engines; in other words, take an ordinary double cylinder hoist and add a low pressure of about twice the piston area of the present one, extend the piston rod through the rear head of old cylinder into the low pressure, and with the cut off added to the low pressure you have a double compound tandem hoisting engine. This allows starting the load with the two high pressure cylinders, instead of having to rely on the high pressure alone as in a duplex compound, with a high pressure on one side and a low on the other. Air does not condense like steam, so that the power in it is utilizable till it has expanded to nearly atmospheric pressure.

As to reheating air the cost is only trivial, for every twenty-four pounds of good coal or its equivalent in wood in reheating air at about eighty pounds gauge pressure an additional horse power for twenty-four hours can be obtained. Whereas, under good conditions, it requires from 96 to 120 pounds of good coal to get one horse power for twenty-four hours from steam, with first-class boilers modernly installed and operated. Using the steam boilers for reheating the air makes it possible to revert to steam in a few minutes at any time, in case of emergency, without loss of time.

In the *Mining and Scientific Press* of April 26th, this year, is a description of the plant at the South Spring Hill mine at Amador City, the planning and installation of which I had in charge. The compressor used is 10x18 duplex single stage poppet valve type, driven by a 30 H. P. general electric induction motor, and formerly run by water power. In this case the blowoff by use of an automatic valve arrangement at the air receiver was led into the steam boiler, so that unless the hoisting engine was idle there was no air wasted; however, considerable air was in this case allowed to blow away on account of the compressor not being equipped with an unloader. When the pumps and drills were not in operation all the air went to the steam boiler, there being reheated and

used by the engine. The largest amount of wood used for reheating purposes was one-half cord per twenty-four hours. Under these conditions the cost of the power to operate the hoisting engines was reduced to one-half, a larger economy than has been made by oil, due mostly to the fact that forty-five pounds gauge pressure would haul the load, which means low pressure air. The compressor ran fifty-nine revolutions per minute, and furnished enough air to run two drills (3⅛x3¼ Rand), breaking sixty tons of very hard ore per day, hoist the same 550 feet, and about eighty tons of water per day with the use of one-half cord of wood. The average consumption of electricity was about 20 to 25 H. P. per day, the bills varying from $135 to $160 per month, and were more than covered by the wood saved as compared with running the hoist entirely on steam.

In milling not much needs to be said, as there electricity is applied direct. Electric motors put at least 90% of the power purchased into the belt, which, of course, discounts water or steam at prevailing prices. It is easily and cheaply installed, is a clean power, should not fluctuate, has a permanent speed regardless of hot boxes or bearings, either one stamp or all of them can be hung up without an appreciable change in speed of the cam shaft. Concentrators can be started at will without varying the speed of others, giving a proper separation at all times, so that to the maximum extent possible, in a mechanical separation there is no sand in the concentrates nor any sulphurets in the tailings. Electricity is the miners' friend, and I trust that in the future, as well as now, those estimable gentlemen who are putting their brains, as well as capital, into these large electricity generating plants, will be working side by side with the miner, for the miner will always be their nearest consumer, and as one prospers so will the other. Mines and mills need no longer be far apart, thanks to our so-called electrical friends, and the advent of electricity, which travels with equal facility up hill as well as down, in sunshine or storm, unlike water, or teams, or railroads, and lays down at our very door, continually without interruption, ready harnessed for work the greatest and most efficient power the world has ever seen, so that the miners can mine and mill on the highest mountain top as easily as in the valley, providing climatic conditions or the topography of the country do not preclude it altogether. As to electricity direct for hoisting purposes, it should be taken up and fathomed, for its successful application is a very important economic proposition.

I desire to thank the various superintendents along the lode in Amador county for courtesies extended and data freely granted.—*Mining and Scientific Press.*

Merrill-Brett Drop Hammer.

E. W. Merrill, Jr., of Brooklyn, N. Y., is introducing in this country the Brett patent steam and compressed air, semi-rotary drop hammer lifters. These lifters can be operated in two ways; either by delivering one, or a series of equal blows automatically, or by giving variable light and heavy blows—blows of the elastic nature best suited for stamping or forging, as the return of the hammer is instantaneous.

The hammer can be made to operate as fast as is consistent with the successful manipulation of the stock in the dies, and the rate of 50 to 70 strokes per minute can ordinarily be obtained. while at a very low fall 100 blows per minute can be given. When necessary, lifters can be made to operate hammers weighing several tons, and these may be as easily worked as the smaller sizes.

The steam having a clear passage to the exhaust, the hammer has a perfectly free fall. The only connection necessary to the drop hammer is a pipe to convey the steam or compressed air, and this can be placed in any convenient location of the factory, regardless of the line shafting.

Compressed air for this purpose is of increasing importance and whenever, by reason of the general use of electric drive, or of water power, live steam is not available for the drop hammer, compressed air can be used in the same manner as steam, and without changing any parts of the machine. No power is lost, while operating, in changing direction of motion, as the piston shaft has but a partial rotation in its bearings, when returning to the starting point.

The important items in the economy of power by this system are in avoiding the necessity of driving heavy line shafting

and slipping belts, and in not expending power while the hammers are not actually at work. The cost of heavy engines, shafting, hangers, and long belts necessary for the usual method of drop hammer drive is avoided and the initial cost of a plant is materially reduced.

These lifters are successfully used in connection with stamping hammers having a very large striking surface; as any unevenness of striking, or looseness in the guides does not in any way affect the lifter or its connections.

The illustration in Fig. 1 shows a self contained automatic drop hammer. The two levers fastened to the right hand side of the drop hammer are respectively connected to a light rod, which controls the throttle, and automatic trip valves.

One of the levers moves between two quadrants containing a series of notches which hold the lever in any desired posi-

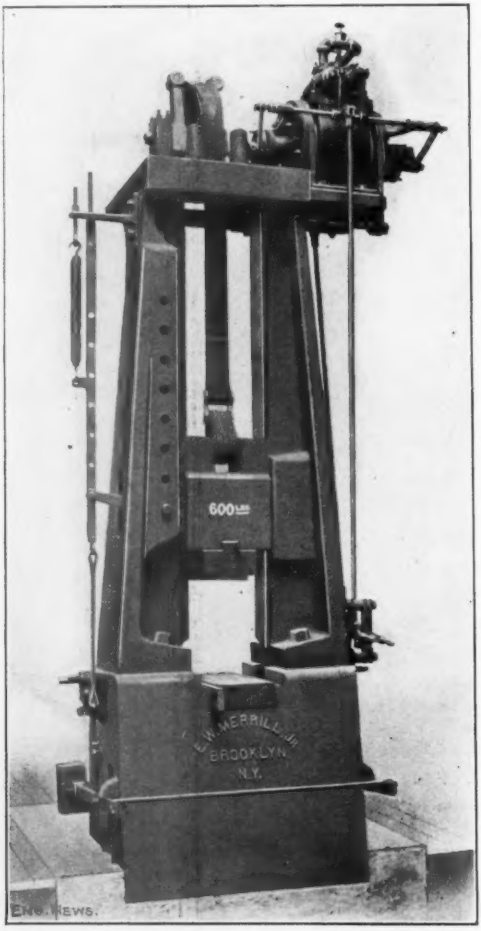


FIG. 1—SIX HUNDRED POUND DROP HAMMER WITH MERRILL-BRETT HAMMER LIFTER.

tion. If the lever is placed in the highest, lowest or any intermediate notch, the hammer will trip automatically at a corresponding high, low or intermediate fall. This change of distance can be made in a few seconds, while the hammer is in operation or at rest.

The drop is worked automatically by releasing the latch with the aid of the treadle, the same as on a board lift drop, a repeated number of blows being given until the foot is removed. The variable light and heavy blows are obtained by operating the throttle lever, as on a steam hammer. There are no rods or slides for the hammer to strike, as the tripping is accomplished by the semi-rotary shaft and without jar.

Almost any kind of an overhead support or platform will answer, as there is no tendency of the platform to rack or sway sidewise, owing to the easy and uniform movement of the parts; the only strain upon the supports is the downward pressure equal to the lifting force. The lifters can also be placed upon the floor above the drop hammer, on the floor behind the base or at right angles to the sides and above the hammer.

The shaft, levers (or lifting arms) and piston, are fastened together to form practically one solid piece. This is the only working part and is free to rotate about three-quarters of a revolution in the cylinder. The cylinder is shown with one end cover removed, and it will be seen there is a division piece which is securely bolted to the side. The bearings in which the shaft turns are long, to give ample wearing surface and are made steam tight by ordinary stuffing boxes. The packing strips are placed in grooves in three sides of the piston blade and in the division piece, and are pressed outward by springs to keep the piston steam tight.

The pulley is strongly built of wrought steel, and turns freely on the shaft between the two lifting arms. The pulley is thus free from all strains of lifting and merely serves as an idler.

Fig. 2 shows a sectional view of the cylinder with the piston, lifting arms and idler pulley in their respective positions. With the parts as here shown, the hammer would be down and at rest. In order to raise the hammer, the steam enters the port A, presses against the piston wing B, and forces the piston to a position, say, at E. When the piston reaches the position E the live steam is cut off and the steam in the cylinder returns through the port A and out to the exhaust; at the same time the piston E returns to the starting point B, this operation being repeated any number of times desired. The lifting arm F being a part of the piston shaft C, consequently when the piston B takes the position at E, the lifting arm F will take the position K. The lifting strap H is fastened to the two arms by the cross-bar G, consequently when F takes the position K, the hammer, which is fastened to the strap, will be lifted a certain distance, this distance being varied by the position of the operating levers. D is the division block and L the relief and safety vent. It will be noticed that the loose pulley J is not

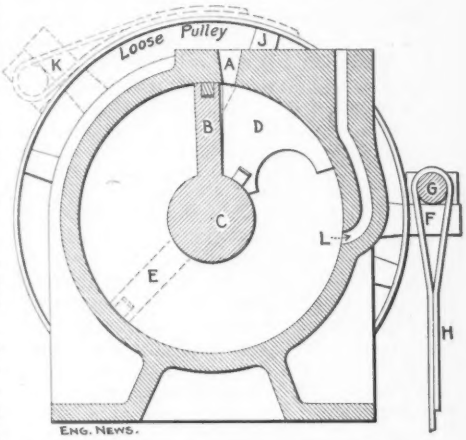


FIG. 2—SECTION THROUGH PISTON OF MERRILL-BRETT DROP HAMMER LIFTER.

fastened to the shaft, and therefore serves merely as an idler to change the rotary movement of the strap to a vertical and central lift, consequently giving a perfectly uniform movement to the hammer. Lifters can be made to raise hammers to any height desired, by increasing length of lifting arms and diameter of pulley.

The great scope of these hammers in the field of die forgings is illustrated by a soft steel locomotive piston weighing 240 pounds, drop forged by one of these large hammers.

Eighteen of these hammers are installed in the forge shop of the locomotive works of the London & Northwestern R. R. at Crewe, Eng.—*Iron Trade Review.*

Experiments with Coal-Cutting Machines in the Ruhr District.

Attempts have latterly been made on a large scale to replace hand labor by machinery in opening out and working coal-seams in the Ruhr basin. Up to within a short time ago the Garforth machine was used in only one pit (Dorstfeld) in this district, but several other collieries are now trying this machine, and, in addition, experiments have been conducted with the American Ingersoll-Sergeant machine, and more particularly with various small machines of German make.

The type of the well-known Garforth machine used in Rhenish-Westphalia is that driven by compressed air, electricity being considered too dangerous in view of the fiery character of the coal. The dimensions are: Length, 10 ft.; breadth, 31½ in.; height, including rails, 29½ in.; weight, about two tons. The machines are constructed by the Gewerkschaft Schalker Eisenhütte, and the arrangement of the cutting wheel varies according to the position of the cut, the level of the cut in each case being capable of a certain amount of adjustment by changing the wheels on which the machine runs. The depth of cut is about 5½ ft., the height only ½ in. The average rate of progress is about 200 ft. per shift, but this may be doubled under exceptionally favorable conditions, or considerably reduced where disturbances are encountered or where the going is very hard.

Wherever possible, the work is so arranged that the cutting is completed in the one shift, the coal being won and hauled during the subsequent shift, whilst during the third shift the ways are advanced, the workings packed, and the timbers put in. A more favorable result is obtained when the wall is sufficiently large for the machine to be kept travelling in the same direction during several shifts in succession, since in this event the winning, &c., can be carried on at the same time. As a rule, however, the loose character of the roof prevents the opening up of such long lengths at a time, and the fluctuations in the dip of the seam render shorter faces imperative.

Since the Garforth machine requires a free space of 40 to 48 inches in width in front of the coal face, very careful timbering is necessary where the roof is brittle; and this is performed by setting up cross timbers about 40 in. apart against the roof, one end being let into the coal face, while the other is supported by a prop 4 ft. back from the face. As soon as the machine in its forward movement has passed one of the props, the face end of the corresponding cross timber is also propped. This method answers very well, and enables the work to proceed without interruption, even where the roof is very poor; futhermore, the urgent necessity for effecting this timbering in a strictly systematic manner has led to an astonishing diminution in the number of accidents through falls of roof.

The undercut coal is got out by wedging, without shot-firing, and when this has been done and the packing has been put in, the machine is then able to retrace its steps, though it is generally found preferable to work the machine always in the one direction, in which case the wheel is dismounted and the machine returned to its starting point, *via* an incline. This is not a difficult matter to carry out. No details are at present available for the institution of a reliable comparison between the expense of cutting by the Garforth machine and by hand in the Ruhr district, but the authorities of the Dorstfeld pit contemplate publishing these data shortly; and, according to verbal reports machine cutting is the cheaper of the two, besides furnishing a larger percentage of lump coal and thus increasing the selling value. An example of a seam unworkable by hand labor being profitably worked by this machine is afforded by a 27 in. seam of gas coal (dip 10 degs.) in one of the northern pits of the Ruhr basin, the coal being too tough and the roof too brittle to render hand working feasible. In taking out this seam with the Garforth machine the face was opened out parallel to the sloping cleats in the coal, thus reducing the dip of the path traversed by the machine to about 6 to 7 degrees. The length of the face was nearly 300 ft., the depth of cut (in the under rock) 5½ ft., and the rate of working about 120 square yards of coal undercut and taken out per diem (two eight-hour shifts). The output per man (hewers and machinists) amounted at first to 1·3 tons per shift, but afterwards increased to 2 tons; the lump coal made up 60 to 70 per cent. of the total.

Owing to the long working face re-

quired by the Garforth machine, its use in Rhenish-Westphalian pits is restricted to longwall work. On the other hand, the employment of the machine enables this method of working to be more extensively pursued than was hitherto possible, the more rapid advance and the abolition of blasting helping to preserve the roof. The machine can be used better in flat than in steeply sloping seams. The limit of its employment in the Dorstfeld pit is at an angle of 30 degs.; but there does not seem any insurmountable obstacle to its use in steeper gradients if fitted with a counterpoise. An essential condition is that the coal should be fairly solid, otherwise the work is hindered by the premature subsidence of the undercut coal itself. A good roof is an advantage, but not indispensable; though an even floor is important, owing to the difficulty of tipping the large wheel in an upward or downward direction whilst cutting. Small inequalities in the floor can be remedied by putting thicker sleepers under the track, or by ripping out the floor itself; but greater changes in the dip are a source of disturbance.

All the other cutting machines tried are of the percussion type, the first to be mentioned being the Ingersoll-Sergeant machine, which makes a cut about 5 ft. deep, the arc of cut being about the same width, and the height diminishing from about ½ in. at the mouth to about 1-3 in. at the bottom of the cut. The dimensions of the machine are—length 7½ ft., height 17¾ in., breadth 20½ in., weight a little over 6 cwt. Although trials have been made with this machine in a number of Wesphalian pits, only two of them have continued to use it to any extent, the reason for abandoning it chiefly residing in its unsuitability to the conditions of stratification prevailing in the coal deposits. Another minor cause is that the machine entails considerable skill, combined with great bodily strength, on the part of the operator, and is not easy to learn, the powers of the operator being overtaxed until he has become expert in the manner of guiding the instrument.

For working the Ingersoll-Sergeant machine a flat or gently sloping seam is essential, as it cannot be used at all when the dip exceeds 15 degs. The roof must be good or great delay is caused by propping, and the coal must be solid enough to preclude risk of caving. In thin seams there is insufficient space for the machinist; and the height of the cut is a defect, as is also the fact that the cut is necessarily made next the floor. The saving in explosives is small as compared with hand labor, the form of the cut differing but little from that made with the pick. In a comparative trial, extending over three months, between the Ingersoll-Sergeant machine and hand labor under fairly similar conditions, the output per man per shift averaged 1·958 to 2·056 tons, at a cost of 2·57s. to 2·71s. per ton in the former case, and 1·423 to 1·792 tons at a cost of 2·98s. to 3·23s. per ton in the latter. The fluctuations in the output in the various months occupied by the trials, however, detract from the reliability of the figures as a basis for accurate comparison. According to the report of the pit officials, the saving effected by using the Ingersoll-Sergeant machine averaged 3d. to 4d. per ton of coal raised; but no allowance is made for the cost of the compressed air. In the experiments referred to, the machine worked at an average speed of 160 strokes per minute, at a pressure of 5 atmospheres. The consumption of air per double shift of 700 minutes is calculated at 318 cubic metres (11,230 cubic feet), on the basis of 2·84 litres (173·3 cubic inches) per stroke; or, allowing 30 per cent. for loss of energy by cooling, friction, leakage, &c., a total consumption of 413·4 cubic metres (14,600 cubic feet) of air per double shift. Now, the average cost of compressed air per cubic metre at a colliery is about a farthing, so that the cost of the air consumed in a double shift would be 8·27s., or, per ton of coal (on the basis of a 40-ton output) raised, 0·21s. (2¾d.). Consequently, the actual saving effected by the use of this machine, under the conditions of the trial, would be merely nominal; and since these conditions were of the most favorable character to be met with in the Ruhr district, there appears little probability of the Ingersoll-Sergeant machine gaining ground in Westphalian mines, more especially as the seams are generally very steep, the roof poor, and the coal of low solidity. On the other hand, the machine is of value in opening out, rapidity of advance being the most important point in this case; and it is considered that in driving ways through the coal, especially at a low gradient, the work could

be done twice at fast by the machine as by hand labor.

The percussion cutters of German manufacture employed in these experiments included the Duisberg machine (Duisberger Maschinenfabrik, successors to Bechem and Keetmann), the Flottmann machine, the Froehlich and Kluepfell (Barmen) machine, the Korfmann (Witten) machine, and the "Triumph" machine (Schwarz and Co., Muelheim), all of which are driven by compressed air. All these machines are similar to the Froehlich and Kluepfel machine shown, the compressed air being admitted to the working cylinder by a reversing valve, actuated by the compressed air from the main cylinder, and either with or without shell valves. The only exception to this rule is afforded by the "Triumph" machine, wherein the admission is governed by the working piston itself. The area of the piston is greater on the rear face than in the front, so that the piston is driven forward with greater force than is exerted in the back stroke; the cushioning effect of the air left in the cylinder prevents the piston from striking against the cylinder head at the end of its travel. Twist is imparted to the cutting tool (point) during the back stroke, by means of a rifled attachment fitted to the cylinder; the forward stroke is a direct one.

The dimensions of the several machines are as follows:—The Duisberg machine weighs about 214 lb., the cylinder diameter is 3·4 in., and the stroke is 8 in.; the Flottman machine weighs 187 lb., the cylinder diameter is 2·8 in., and the stroke 7¼ in.; the Froehlich and Kluepfel machine weighs 198 lb., the cylinder diameter is 2·9 in., and the stroke 6 to 8 inches; and the Korfmann machine weighs 123 lb., the cylinder diameter is 2·4 in., and the stroke 8 in. Altogether, these machines differ little, if anything, in construction from the rock drills of the same makers, the chief point of interest being centered in the method of attaching them to the stand, and in the shape of the cutting tools, both these features being specially designed for the purpose of working the machines as coal-cutters. In addition to an adjustable sleeve or collar, gripping the upright of the stand, this connecting device is arranged so as to permit the cutting machine to be rotated. In the Duisberg machine this movement is effected by means of the Eisenbeis patent guide sector, which causes the cutting tool to describe an arc, and, being adjustable, enables the cut to be made in any required direction. A similar arrangement is fitted to the "Triumph" machine. In the other machines the connections are of a simpler character, that of the Froehlich and Kluepfel machine consisting of a clutch fitted with a lateral bore, into which fits a projecting pin on the machine. When the machine is to be used for horizontal cutting—*i. e.*, work in a plane at right-angles to the stand, it is firmly connected with the clutch, which latter then sits loose on the upright, so that the machine can be turned about the upright by means of the lever provided for that purpose. For vertical cutting the clutch is tightened on to the upright pillar and loosened with regard to the machine, so that the latter can move in a plane parallel to the axis of the pillar. A similar attachment is fitted to the Flottmann machine. In the Korfmann machine, however, the clutch is provided with two arms, one of which has a vertical bore and the other a horizontal one. For horizontal cutting, the trunnion of the machine is attached to the vertical bore, but to the horizontal one for vertical cutting; and when the cut is required to be made close against the floor an extra arm is attached to the vertical bore for carrying the machine. Taking into consideration all the relative advantages and defects of the two kinds of fittings, preference is generally accorded to the clutch form, which is in addition much cheaper than the guide sector.

The cutting points of these machines are of various design. All these points are provided with a tapering bore for attachment to the piston-rod of the machine. Numerous experiments have shown that an appreciably higher efficiency is obtained with the simpler cutting points than with the more elaborate pattern, while the advantage possessed by the latter, of being easier to sharpen, is discounted by the fact that the points are not exposed to any great amount of wear in cutting through the comparatively soft material, coal. As regards the relative defects and advantages of the German machines, that of Korfmann has the advantage of being light and therefore likely to be suitable for use in steep seams, where the heavier Duisberg and Froehlich and Kluepfel machines can-

not well be employed. Whether this lightness means extra cost in repairs still remains to be proved; but the slightly inferior efficiency in cutting, per unit time, would seem to be compensated by the smaller time needed to set the machine in position for work. Both the Duisberg and the Korfmann machines exhibit the defect that they stick at the end of the forward stroke in the event of the bit failing to encounter sufficient resistance, in which case the machine has to be swung round till the bit is out of the cut, and the piston must be pushed back by hand, after closing the admission valve. This is particularly liable to occur at the commencement of a cut, and always means a certain loss of time.

Some endeavors have been made to alter the German machines by removing the twist mechanism, so as to approximate them more closely to the type of the Ingersoll-Sergeant machine; but the increased cutting capacity would seem to be counterbalanced by an irregularity of cut, and a tendency for the bit to slide off corners forming within the cut itself, though in one case this defect was found to be overcome by more skilful handling. In their usual form the German machines are generally fixed in position by setting up the pillar 30 to 40 inches way from the coal face, fitting the clutch on loosely, inserting the machine in the latter and adjusting it at the proper level for making the cut, and finally connecting up the compressed air supply. Two men are usually needed to set up the machine, and the task may occupy as much as one to one and a-half hours, according to the dip and thickness of the seam and the condition of the roof; but in a thin flat seam a light Korfmann machine can be set up by one man in five minutes. The width of the cut averages 3 to 5 inches, according to the bit used; and a depth of 10 ft. can be cut without difficulty, though it is usually preferable not to exceed 6 to 8 ft., and the breadth seldom exceeds 10½ ft. in wide faces. To prevent the coal breaking down when brittle, the undercut portion must be well spragged, as it might otherwise bring down the next portion before the completion of the cut, and thus hinder progress.

From some comparative trials made, over a period of three months and under identical conditions, with hand labor and with the Froehlich and the Duisberg-Eisenbeis machines, it appears that the rate of progress made by the machine averaged 60 per cent. more than that obtained by hand work, whilst the consumption of explosives was reduced by about one-half. The total cost of mining with the pick amounted to 26·3s. per metre run, but only 14s. with the machines, or including the estimated cost of the compressed air, allowance for waste, depreciation of plant &c., to 16s., a saving of 10·3s. The output per man per shift was increased from about 1·6 tons by hand labor to about 2·6 tons with the machines. Similar results were obtained in another set of trials with the Froehlich and the Flottmann machines, the saving in blasting material being particularly noticeable.

No data are as yet available for numerical comparison of the efficiency of the Garforth, Ingersoll-Sergeant and German machines. The Garforth machine cannot be used for opening out, but the results obtained in long-wall working show that the output of this machine is far superior to the percussion machines in all places where its use is feasible. The Ingersoll-Sergeant machine is superior to the German machines in its stronger construction; but it is rare that the conditions of deposit in the Ruhr basin are suitable for the employment of this machine. The limit of dip under which the German machines can be successfully used has not yet been ascertained; but they are apparently capable of less restricted employment than either the Garforth or Ingersoll-Sergeant machine. Up to the present the German machines have only been used in opening out work, but there seems no reason to suppose they would give less favorable results in actual winning.

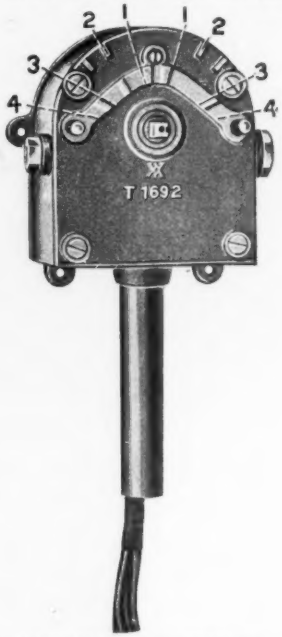
So far the use of machines in the Westphalian field has been confined from hard to medium seams, and it appears questionable whether they are applicable to softer coal at all; if not, they will be shut out from a large number of the pits in this district.

In addition to the diminished cost of machine work, the latter presents certain other advantages, including a larger percentage of lump coal and less waste in winning and washing; the possibility of taking out seams hitherto unworkable; greater rapidity of working; and reduced danger

in mining. The larger percentage of lump coal results from the greater extent of cut possible with machine work, and the consequent diminution in the use of explosives. The shape of the cut made by the German machines resembles that of the Garforth machine, though not so deep; and this shape makes it feasible to take out any parting in the seam, by means of the machine, and so yield a cleaner coal. The possibility of winning hitherto unworkable seams means an increase in the coal reserve, and a longer life for the coal-mining industry, as well as improved utilisation of the costly preparatory work. The greater rapidity of machine work enables the attack to be concentrated, timber saved, and the effects of rock pressure (a time factor) to be reduced. The diminished danger accruing from the use of machines is largely due to the reduction in the consumption of explosives, and is more especially noticeable in the case of falls of rock shattered by blasting. The use of machines also necessitates systematic working, since, if the timbering be defective, premature subsidence may retard working for a considerable time; and therefore it is to the interest of the men to see that the timbering is well done at first. Accidents from falls of coal are less frequent, because the machinist has the machine between himself and the face, and is therefore less exposed to danger from this cause. The statistical reports from the United States conclusively prove the favorable effect of machine work on accidents, and a similar experience has been gained in the Dorstfeld pit, where 150,000 tons were got by machining in 1900. The number of compensated victims of accident in this pit has declined since the introduction of machine work, from 7 per 1,000 miners in 1897 to 3·51 in 1900, that is to say, by 50 per cent.—*Colliery Guardian, London.*

The Brooklyn Elevated Railway Chooses the Westinghouse Electro-Pneumatic System of Train Control.*

The Brooklyn Elevated Railway Company has just given an order to the Westinghouse Electric & Mfg. Co., for 210 multiple train-control equipments, which will be used for the operation of electrically propelled trains on its lines. A few years ago the management of this road decided to discard steam locomotives and to operate all trains electrically. Before making such a wholesale change, however, it was deemed prudent to test exhaustively the different methods of handling electric trains. If the steam locomotive were to be replaced by simple electric locomotives, many of the advantages of electric traction would be sacrificed. In order to reduce the dead-weight hauled and to obtain a higher tractive effort when starting, it is better to place the driving motors on the trucks of several of the passenger cars of a train and thus take advantage of the weight of the cars than to put the motors on a locomotive, which must be artificially loaded down to give it the necessary adhesion. Other reasons for choosing a system employing a number of motor cars per train rather than a single locomotive were that, since the service is fluctuating, during a part of the day the large motors of the locomotive would be operated at a light load and consequently low efficiency. Moreover the trains could not be broken



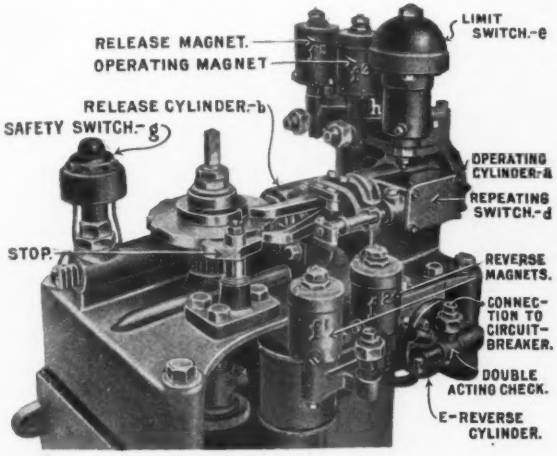
MOTORMAN'S CONTROLLER.

*We are indebted to the *Street Railway Journal* for the use of the accompanying illustrations.

up into single units, as is possible when a number of the cars carry their own motor equipments.

The Brooklyn Elevated Company, therefore, went to the leading electrical manufacturers who had developed systems for controlling a number of motor cars in a train, and asked them each to equip a number of model trains for testing purposes. These trains were placed on the Brooklyn road a few years ago and have since operated in the regular daily traffic. The companies furnishing equipments were the Westinghouse Electric & Mfg. Co., of Pittsburg, the General Electric Co., of Schenectady, N. Y., and the Sprague Electric Co., of New York City. Careful

George Westinghouse, and, on account of his long experience in railroad and electrical matters, is eminently adapted for the operation of trains under everyday railway conditions. The Westinghouse system involves the use of compressed air for moving the current-controlling apparatus, electro-magnetic valves governing the admission of air to the controlling cylinders and low voltage electric circuits running from car to car for controlling the action of the magnet valves. The connections for the low voltage circuits are the only ones which have to be established between the cars of the train, no air connections being required outside of the ordinary brake hose. A complete equipment



TOP OF CAR CONTROLLER.

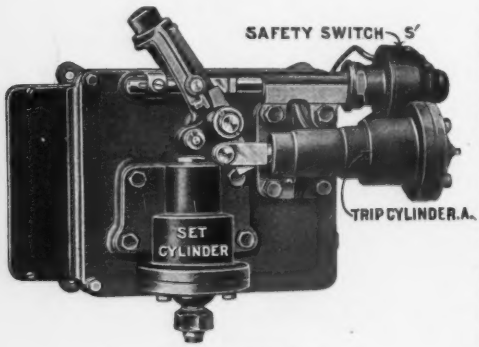
records were kept of the number of miles run by each train, the number of accidents met with, the cost and time required for repairs, the comparative convenience in operation, and all other matters that might influence the decision. The result of this investigation has been the placing of the order mentioned above. All steam locomotives now in use will be in a short time replaced and trains will be operated by the Westinghouse system. In addition to the order for 210 cars, the company has already purchased about 150 equipments which have been in satisfactory operation for nearly a year.

The Westinghouse Multiple Train Control system has been developed by Mr.

for each motor car consists of two or four electric motors, a controller very similar to the controllers used on ordinary street cars, and one or two motormen's controlling switches, from any one of which all the car controllers on the train may be operated. The car controller, as stated, is similar in design to the ordinary form of hand controller which has been successfully used on electric street cars for many years. It consists essentially of two drums which revolve in bearings, and stationary contact fingers which make contact with points upon the revolving drums. The large, or main drum, opens the main circuit and makes the motor and resistance combinations; the small drum reverses the

motors. A multiple control switch is placed at one or both ends of each motor car and by means of the one at the front of the leading car the motorman controls the action of the controllers on all of the motor cars in the train. Some of the points of superiority of this system over other systems may be stated as follows:

It employs compressed air for operating the control apparatus and thereby uses a powerful and reliable agency. It uses the standard type of controller and standard types of valves and magnets, the latter having been used for years in the operation of the Westinghouse electro-pneumatic system of switches and signals upon the largest railways in the world. It is the only system in which the control circuit is isolated from the main power circuit. The



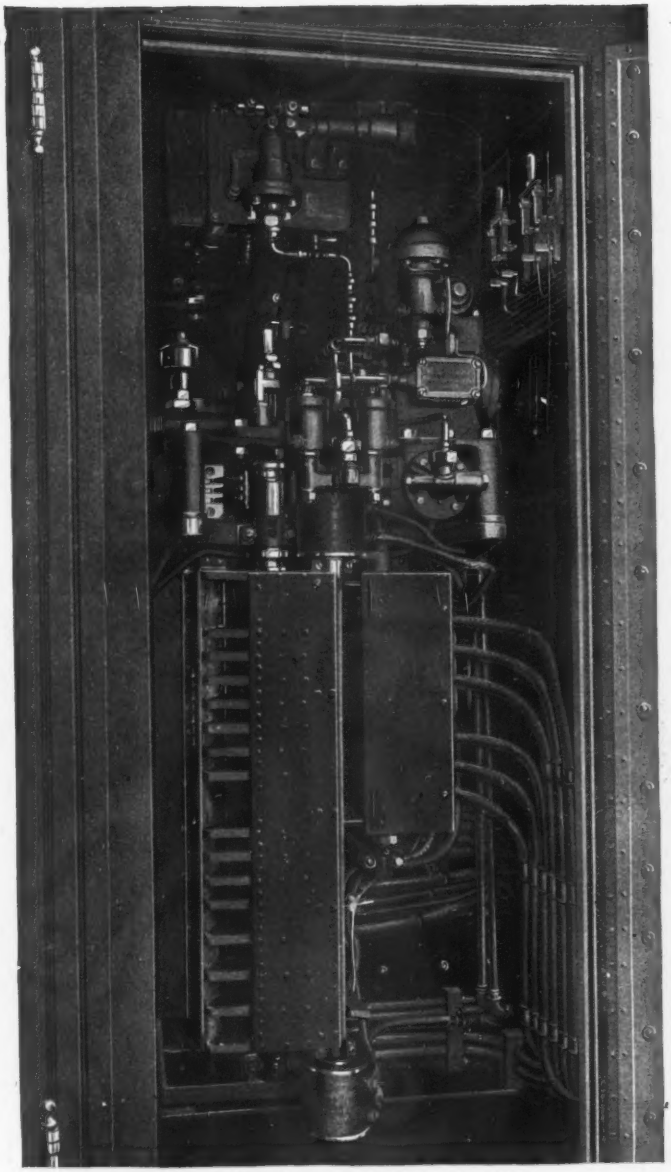
CIRCUIT BREAKER.

control circuit is, therefore, not affected by a momentary interruption of current due to ice and sleet on the rails, or other causes. With the low voltage current, grounds and short circuits at the connectors between the cars during stormy weather or fires resulting from high voltage circuits through the train are entirely eliminated. The current for the motors is simply collected from the third rail, led through the local car controlling apparatus to the motors, and then back to the service rails, and does not pass from car to car. The controlling apparatus is so located that the motorman may have convenient access to all parts from the platform.

The motor circuits on any car are automatically opened in case of excess current and they can all be simultaneously closed at the will of the motorman. All controllers are automatically turned off by the application of the automatic air brakes, which is an important point since in case of a train breaking in two the brakes are automatically applied and at the same time the power is shut off. With other systems under some circumstances, it has been found impossible to shut off the power from some of the cars, while in the Westinghouse system there are a number of ways in which this may be accomplished, greatly reducing the possibility of accident. Both controllers and circuit breakers are opened by a breaking in two of a train, this action being independent of and in addition to the effects obtained by the application of the air brake. The controllers may be operated by hand, thus permitting the train to run to a terminal station in case of any derangement of the controlling apparatus. The operation of both brakes and controllers is effected by a single air hose connection between the cars, the air compressor which furnishes air for the brakes also furnishing air used to operate the controllers.

The Brooklyn Elevated will equip all its new cars with four motors each. The 150 cars now in use equipped with the Westinghouse system have each two motors. The trains on the road are made up of five or six cars, two or three of which are usually motor cars. When these trains reach the suburbs they are broken up into smaller units of one or two cars, each of course containing a motor car, and the small trains branch off on different divisions. By the use of this system it is possible to operate cars individually as on ordinary trolley roads, or to make them up into trains of any length. Also, any proportion of motor cars may be used, making it possible to obtain any desired amount of power for starting the trains quickly, which is necessary in any service involving many stops.

The significance of the investigation into the different systems of train control which has been carried on by the Brooklyn Elevated will be appreciated when it is remembered that the Rapid Transit Subway in New York will be operated by electricity and, since its trains must be operated at high speed, some system of multiple train control will have to be adopted. There is, also, the Pennsylvania tunnel system under New York,



VIEW OF CONTROLLER COMPARTMENT OPEN.

which the ordinance recently passed by the Board of Aldermen requires must be operated by electricity or some other agency not involving burning of fuel in the tunnel.

In the great transportation problems which are being solved in New York City, the Westinghouse Company has borne a prominent part. It has furnished the power equipment of the Brooklyn Elevated, also the power equipment of the Manhattan Elevated, including eight of the largest generators ever built. It has contracted to furnish the power equipment of the Rapid Transit Subway, the powerhouse of which will contain six units similar to those furnished to the Manhattan people, while the Brooklyn Elevated contract indicates a satisfactory solution of the train control situation.

Ventilation in Mines.

Of equal importance with safety appliances and precautions in the development, equipment and operation of mines is the necessity for an abundant circulation of pure air in mine workings. Excepting in coal mines, and certain metal mines, where fire damp occurs, though the latter are comparatively rare, too little attention is given to ventilation. Incidentally some mines, through the agency of connections with neighboring property, or by reason of having two or more shafts connected within their own lines, are splendidly ventilated. In such mines only raises, winzes and the bottoms of the main shafts are points where air is temporarily badly ventilated, but even these are far superior to the main workings of other mines not having the advantages of several shafts or outside connections.

In seeking the reason for this neglect to provide proper ventilation it is found that in the early history of the mine a ventilating fan of small size was put in and run until it became absolutely impossible to continue development without more air. A larger blower, sufficiently large for all time, it was supposed, was installed with a special engine and run it, and a new 12-inch pipe line. Down to 1,000 feet this ventilating fan and engine may have answered admirably, and made it possible to supply every drift, raise, stope and other excavation with fresh air. But mining operations do not cease, and year by year the workings become deeper and deeper, the long levels are driven out longer, and each succeeding day finds a constantly increasing need of more pure air. While the existing condition is recognized, usually from reasons of economy—false economy—nothing is done to provide better ventilation, and so the situation grows daily worse. Finally, the lower levels, at a distance from the shaft, become simply intolerable. The air is always dense, close, hot, heavily laden with nitrous and carbonic gases, and unfit to breathe. The men stagger from the freshly blasted faces and stopes, rendered weak and sick from lack of oxygen and from breathing poison. Something must be done to improve conditions or work cannot progress. Happy thought. A new ventilating fan is placed on the 1,000 or 1,200 level, run by water motor driven by mine water caught up several hundred feet above, or if sufficient power is not obtainable in this manner the fan is run by electricity. This new fan is intended to furnish "pure" air to all workings below its station. But does it accomplish the desired result? Scarcely. It will produce a current of air, but the air driven down into the lowest levels is that which is forced out of the long drifts and stopes of the level where the new fan is situated, and from the levels above, and this air is already overladen with foul gases. These old levels and stopes are full of rotting timbers, which furnish an immense amount of carbonic acid gas, beside that expelled from the lungs of the workmen, and the further exhaustion of the oxygen by breathing and the lights. In certain portions of the mine where the conditions are almost unendurable the superintendent favors the workmen by removing them, and in turn permitting them to work in various parts of the mine where the air is a little better.

Where air compressors are employed to supply machine drills the exhaust of the drills furnishes a given amount of air, but even this is laden with the oil driven into the pipe line from the cylinders of the air compressor, and not particularly agreeable to breathe if one were out of doors, but the miners gladly welcome even this small advantage in tneir position, if it is an advantage.

Is it economy at all to permit such a condition to obtain, or having been reached

to allow it to continue? It is a recognized fact that this ventilating apparatus was at one time efficient, but the mine usually, sooner or later, outgrows it. Is it not far more economical to provide the power with a fan large enough to thoroughly ventilate the mine, and to drive a sufficient volume of pure, fresh air from the surface to every heading, raise and stope that the men may accomplish more work—and this they certainly can, and will, too, without urging.

The unfortunate miners are afflicted with "miners' consumption" and it is "hereditary," is the common expression. Nothing of the sort. It is simply that they are starved for lack of the life-giving oxygen, and though they are stout, hardy men, human endurance has its limit with the strongest of them.

It is not only proper to provide a sufficient supply of fresh air to the men below ground, but it is good business, and the increased amount of work accomplished by the miners will quickly pay for the entire expense of the new ventilating plant.

Decaying timbers in mines create a vast amount of carbonic acid gas, and the removal from the mine of all decayed timber that can be recovered will do much to improve the condition of the air, even though it be still fairly good. The practice of throwing decayed timbers in the "fill" of the mine is a very bad one, for while it is only temporarily serviceable as filling, it vitiates the air to an extent far beyond its value as filling, and it really costs little to hoist it to the surface.—*Mining and Scientific Press.*

Pneumatic Tubes for Mail Service.

Although it is not very generally known, there have been many plans on foot during the last few years to equip all the large cities of the United States with systems of underground pneumatic tubes for the transmission of mail and merchandise. This movement has already been in operation for three or four years in several cities in the East, but it is doubtful whether even the residents of these cities fully appreciate the importance of the system.

How many people living in New York, know, or if they do know it, regard it as anything out of the ordinary, that the greater part of the mail service between New York and Brooklyn is carried on through two large tubes, which run over the Brooklyn Bridge. How many know that the mail is sent from the Grand Central Station to the General Post-office through a large tube, three and one-half miles in length; or that several of the large telegraph offices in New York exchange messages through pneumatic tubes. Philadelphia has its business district and two large railroad stations connected with its post-office by tubes, and talks of installing a mercantile express tube service, stretching out in all directions from the center of the city. Boston sends most of its mail from the post-office to the railroad station through such tubes, and Chicago has adopted it to a certain extent. It is, however, in the European cities where we shall find the system further advanced and used more extensively. London, Paris, Vienna and Berlin are all underlaid with a network of tubes, and many other large cities have either already adopted the system or intend to do so in the near future.

In the very center of all the rush and roar of the New York post-office we find the terminal machines of three great lines of tubing. One runs into the heart of the business section, and ends in the Produce Exchange, another which takes care of the greater part of the home correspondence runs over the bridge to Brooklyn; while the third extends to the north and terminates in the Grand Central Station. The carriers which travel through these tubes are very similar to those in use in so many of our stores to carry change to and from the desk. They are eight inches in diameter and about two feet long, having a capacity for about six hundred letters, and weighing, when filled about twenty-five pounds. The operation of sending and receiving is very simple. A clerk hurries up with a tray, opens one end of a carrier, fills it with small bundles of letters, snaps the lid shut, thrusts the carrier into the machine, and pulls a lever. There is a roar, and then a subsiding rush, the clerk lets go of the lever and repeats the operation with another carrier. We can better see how much time is saved by the use of these tubes, when we know with what great speed the carriers travel. A carrier going from the Grand Central Station to the post-office, a distance of a little over three miles, goes the first mile

in about two minutes and as the speed increases as it goes, it covers the second mile in a minute and a half, and the third in something less than a minute. Post-office officials tell us that mails now catch trains at the "Grand Central" leaving an hour ahead of those caught during the old wagon system, and that for mail going far to the north and west, this sometimes amounts to a saving of twenty-four hours during the trip. Letters coming from the west now catch steamers for Europe, which they formerly missed by a few hours and were thus delayed for several days. When we take all these things into account we see that it is almost impossible to figure the saving not only to New York, but to the entire world, affected by this one system of pneumatic tubes.

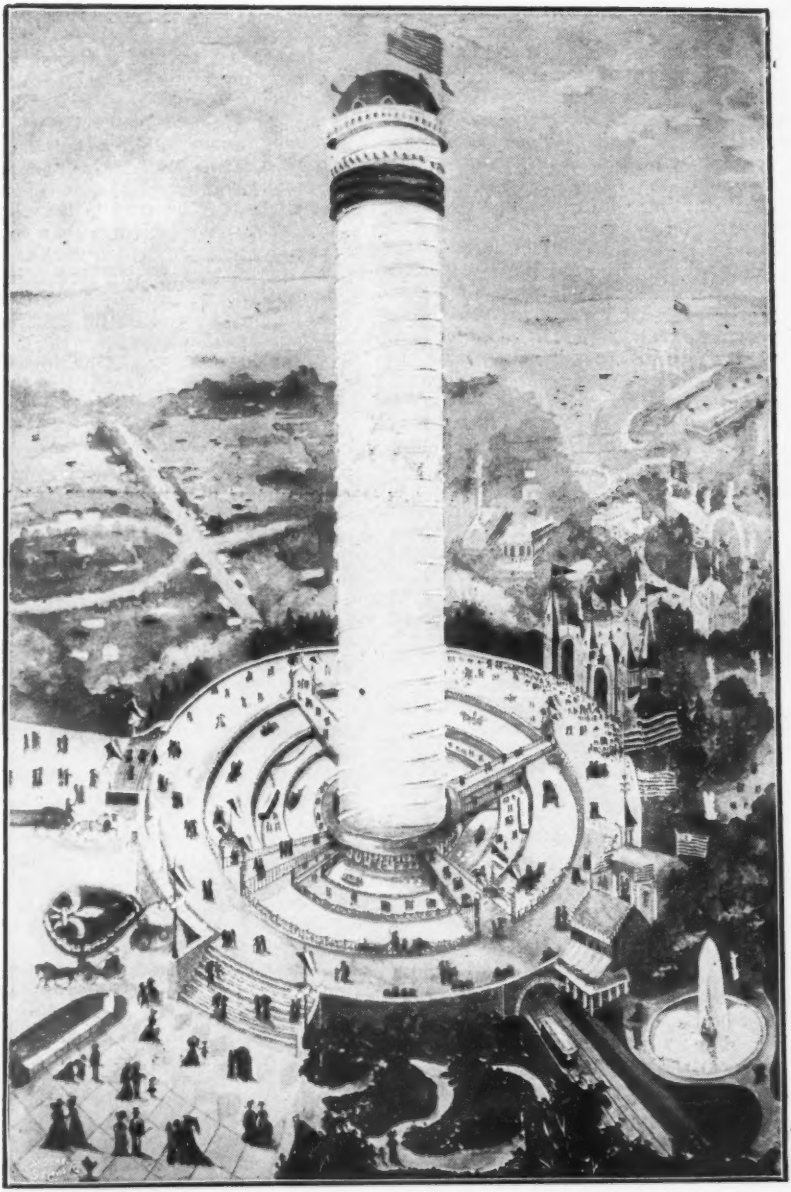
In the European cities there are two distinct systems of pneumatic tubes employed, namely the radial system and the circuit system. London employs the radial system; that is, the system is in the form of a many pointed star, the general office being in the center and the substations at the points. Both outgoing and return tubes extend to all these points. In Paris, where the circuit system is used, a single pipe starts from the central office, makes a tour of all the outlying offices and returns to the starting point. London operates over thirty-four miles of tubing connecting with forty-two sub-stations. The Paris system connects only about twenty stations, but handles nearly as much mail as London. Paris thus has a great deal lower running cost than London, but on the other hand a great deal of time is saved by means of the latter system. In London when any mail goes wrong it is returned immediately upon its arrival at the first sub-station. In Paris, however, the carrier must make the complete circuit of the city before it can again reach the main office. Berlin has thirty-eight stations connected by about twenty-eight miles of tubing arranged on the radial plan, while Vienna employs the loop system.

Oddly enough in most of these cities the carriers are not propelled directly by compressed air. A short solid piston shoots through the tube and thus draws after it one or more carriers. One of the chief objections to the pneumatic tube system has been that in case of accident to one of the carriers, the tube would be blocked, and it would be almost impossible to recover the mail. The possibility of blockades caused by rear end collisions, is done away with in Paris by operating the tubes on a regular block signal system. An electric device automatically keeping more than one carrier out of each block. It has been proposed to lay a very large pneumatic tube under the English channel extending from London to Paris, but the engineering difficulties in the way of this plan are so great as to render it highly improbable if not altogether impossible.

A very complete expert investigation has lately been made into the cost and operation of the pneumatic tube service, with a view to determine whether it should be owned, leased, extended or discontinued by the government. The committee fully sustains the method as a most valuable and mechanically successful system. For New York the committee discusses a plan for the installation of eighteen miles of new line. This would involve the connection of twenty-one substations with the main office. The annual rental proposed is $398,500; but there would be a large reduction in wagon service, elevated railway service and incidental savings, which are reckoned at $101,052. If the system is extended it is proposed to reduce the charge for special delivery. For Brooklyn thirteen and one-half miles of new tubing is proposed, connecting seven new stations at a cost of $172,097. All proposals include the continuance of the existing systems.—A. W. Bacon, *Yale Scientific Monthly*.

Compressed Air for World's Fair Tower at St. Louis.

Inhabitants of the world in every nation, civilized and uncivilized, have been called on to build a tower on the World's Fair grounds at St. Louis, that will be a lasting monument to the grandeur of the exposition and the most magnificent tower ever built. For this purpose a company has been organized, known as the Crystal Palace Tower Co.—of which Norton W. Bowman is president, and which has its headquarters in St. Louis. The scope of vastness and grandeur the plans comprehend are almost bewildering to the



TO BE THE WORLD'S GREATEST TOWER.

human conception. Towering to the dizzy height of 1,050 feet the great steel column, 565 feet around, will be crowned by an Acropolis containing the only exhibition of a wireless telegraph station in the world. Over this will float the largest flag staff ever made. Here too at this sky-piercing altitude will be an observatory that will have a capacity of 7,000 visitors at one time. This observatory in the clouds will be reached by inside elevators and by an endless palace excursion car, encircling the outside of the column, which will wind its way heavenward from the base by means of 114 side-wheels traversing a series of spiral railway tracks affixed to the outer walls of the column. In the accompanying illustration the car may be seen encircling the tower near the top on its way to the observatory. The motive power is to be furnished by compressed air machinery. The car is three stories high and will seat 800 people. But grandest of all will be the crystal light effect from which the construction derives it name, "The Crystal Palace Tower." A veritable cystal palace of light will be produced within the column by the suspension of millions of cut glass cystals, strung on wires suspended from the top of the tower and curtaining the entire inner surface of the column with a network of reflecting surfaces upon which a flood of vari-colored electric lights will be precipitated. The crystals will be in constant agitation and the marvelous blending of the myriad rays of mellow light will reflect all the tints of the rainbow.

A lagoon will surround the base landing of the palace car and here is to be a reproduction of ocean bathing. The bottom will be laid with salt blocks and high billows will result from a mechanical wave-producer. Other features of the structure will be the largest photograph gallery in the world, located in the Acropolis; a promenade street car and automobile landing; a grand boulevard above the street car landing; an arena for games, bicycle and automobile races; a terraced grand promenade just above the grand boulevard, from which the numerous attractions about may be viewed. After the fair the tower is to be remodeled to form a permanent exposition.—*Popular Mechanics.*

Heat, Man's Most Useful Servant.

Heat is a very interesting element. It is interesting to note that the 10 miles of air which immediately envelopes the earth contains more heat than could be produced through burning all the coal that is beneath the earth's surface, including also all the wood upon our planet. It is also a fact that there is more coal in the air in the form of carbonic acid gas than in all the coal mines put together; and when we consider that at 70 degrees Fahrenheit we are in a temperature that is 410 degrees hotter than liquid air, which still contains over 100 degrees of heat, and that the difference between 70 and 212, the boiling point of water, is only 142 degrees Fahrenheit, then we can safely make up our minds that we are living in a very hot furnace. Some great inventor will make use of this fact some day to the great benefit of mankind.

All of this heat must come from somewhere and according to our present knowledge the primary source of all energy on the earth is the sun. I will not stop to discuss the various theories as to whence the solar heat originally came, and how the enormous waste continually going on is made good. I will content myself with stating that the compound rays emitted by the sun warm the earth, produce vast movements of water through evaporation and the formation of clouds and so give us warmth and moisture, upon which the growth of the vegetable and animal kingdoms depend. Vegetation derives most of its food not from earth, into which its roots penetrate, but from the air. The lovely mantle of green which adorns the productive portions of our planet is not intended to beautify alone; the vast surface of leaves exposed to the air has the property, under the influence of the actinic or chemical rays of the sun, of decomposing the carbonic acid in the atmosphere, of assimilating the carbon, converting it into the ligneous parts of plants, and releasing the oxygen, which is essential to the life of animals. This is inhaled, and, again rejected, is restored to the atmosphere in the form of carbonic acid.

The quantity of carbon in the atmosphere is relatively small, varying from three parts by measure to ten parts in 10,000, but, absolutely, the weight of carbon thus diffused is greater than all the

carbon in a solid form on the earth. The sources of carbonic acid are the expirations of animals, the combustion of vegetable and animal substances, and emanations of a volcanic character. Wood contains from 46 to 55 per cent. of carbon, all derived from the atmosphere; and because the quantity of carbonic acid there is so small, the immense leaf surface is necessary to collect sufficient for the growth of the plant. By long continued contact with moisture and warm air, wood slowly decomposes by combining with oxygen, and is converted, according to circumstances, into vegetable mould, peat, lignite, or, finally, into coal, which, in the form of anthracite, consists of almost pure carbon.

The work done by the sun's rays in decomposing the carbonic acid of the air is very great. The energy which must be exerted to separate the carbon from the exygen in carbonic acid is the same as that developed by the combination of the same element in combustion, and has been determined by experiment to be equal to 14,544 units of heat per pound of carbon consumed. By an easy calculation it can be deduced that every ton of carbon separated from the atmosphere by the sun's rays in twelve hours involves energy represented by 1,058 horse power expended by the sun, but as this energy operates over an enormous leaf surface, its effects are quite imperceptible to our senses.

Mechanically the successes of the nineteenth century have depended upon the utilization of heat.

Could we see air and heat, men would have been led to many further discoveries, and many difficult problems in this connection would have been easy for inventors.

Heat exists in all materials as well as in air. If we take a given amount of atmospheric air, say in a bicycle pump, the air has the heat of the atmosphere, which is, say 70 degrees Fahrenheit. Now we push the piston to compress the air. Through compression a large volume of air becomes a small volume; the 70 degrees of heat cannot be squeezed out of the air as water is squeezed out of a sponge. A volume of air has been compressed! Pressure is obtained, but while doing this a large volume of heat also has been made to take a smaller compass. What happens? Air notifies us of its presence through pressure; heat tells us of its presence through degrees. Without pressure there is no air (vacuum); without degree there is no heat (critical temperature).

The compressed air in the bicycle pump gives us more pressure and more heat. It is possible to so compress air and its heat with it that it will make the pump red hot. On the other hand, if the pressure is entirely released to its starting point, it may seem like magic, but both the air and the pump will become instantaneously as cold as when started. By following this principle we will be able to produce artificial cold. Upon this artificial ice making is based. If we again snove the piston down in the bicycle pump and compress the air and thus make the air and the pump hot, and in this state plunge the pump and the compressed air in it into cold water, thus cooling the hot air in the pump to say 70 degrees Fahrenheit, its starting point and then entirely release the pressure on the air, it will be found that the pump will instantly become intensely cold, for the reason that the heat produced through compressing the air has been taken out, and by allowing the air, through the release of pressure, to take up its original volume, there is a lack of heat. Lack of heat is cold. A very easy proof of this can be had by using a "Sparklet" for carbonizing water. A small amount of liquid carbonic acid gas through release of pressure is allowed to become a large volume of gas. The water may be warm, yet by the discharge of the contents of the Sparklet into the bottle, water and bottle become ice cold instantaneously.

Making artificial ice or producing cold, consists of compressing air or a gas, thus making it hot, cooling the gas in its compressed state with water, and allowing this cold and compressed gas to expand back to its original size. The same gas is recompressed, recooled and expanded over and over again for years. By making ice you are making use of the cold produced, but if you do not make this use of the cold, and let the process continue, liquid air, solid air, or something even colder is obtainable.

The air, even at a temperature of freezing, still contains a great deal of heat. All the heat of all the air at the freezing point, if concentrated by compression, is enough to burn the City of New York off the earth in five minutes; it would melt all the iron in the world in a few seconds; it would

make steam for all the boilers and engines of the earth for years.

Having satisfied ourselves that there are other ways to produce heat than to have fires, and that there are other ways to produce cold than by means of having ice around, we are now ready to understand the fact that by burning a fire we not only produce heat, but cold as well. Let us see how this happens. Suppose we burn a gallon of oil. The gallon of oil will become, first, vapor, then gas, then finally a product of combustion. In this form it is at least 500 times as large as when it was oil. You have burnt the oil, you have produced heat, but you have allowed it during the process of burning to expand, to become something very large; you have the ice machine in the midst of your fire. The heat-producing qualities of the burning oil are, it is true, greater than the cold produced through its expansion, so the heat wins the contest, but at a very large loss. If this cold-producing quality of a fire could be prevented, there would be no trouble to produce undreamed-of degrees of temperature.

If we could burn the gallon of oil, and instead of allowing it to expand to a volume of 500 gallons of gases in the open air, we could provide a chamber which has a capacity of only 250 gallons, the products of combustion, instead of being at an atmospheric pressure of 15 pounds, would be under a pressure of 30 pounds to the square inch. The heat would be condensed as well as the gases. Now if we make the chamber so small that instead of 30 pounds we create 200 pounds pressure, a correspondingly high degree of temperature would be produced.

Pressure has a great deal to do with heat. Pressure controls the boiling point of all liquids. Water in a vacuum or without pressure on it, boils at a lower temperature. On high mountains, where the pressure of the atmosphere is less than 15 pounds, the mountaineers cannot cook their beans or potatoes, as the water boils away before it gets hot enough to cook with it. With enough pressure and a strong enough vessel to hold it, it is possible to heat water red hot without boiling it. On the other hand, it takes but little heat to raise the temperature of water from freezing to the boiling point, but it then takes a great deal of heat to tear the molecules of the water apart and convert it into steam, yet the steam will have the same temperature as that of the water. The heat goes into expansion, and as steam is 1,700 times as large as water, a great deal of heat is needed to make up for the increased volume.

Heat can be produced slowly or rapidly. Tne iron that rusts and the food that is digested in our stomachs are both burned slowly. Oil on the fire burns millions of times faster than the iron rusting. Exploding gunpowder burns many times faster than oil on the fire.

It is the oxygen of the air that does the work, but only 21 per cent. of the air is oxygen. The percentage of nitrogen and the percentage of carbonic acid gas do not help. For that reason a great deal of air is needed to make a fire burn, and the largest loss which steam engineers encounter is the heating up of this 79 per cent. of neutral gases to the temperature of the fire and then having to send them off through the chimney. Coal, in burning, consumes two and one-half times its weight of oxygen. The neutral gases are four times as great in volume. The expansion of the gases also absorbs a great deal of heat. For these reasons the engineer looks at the chimney with a sorry eye.

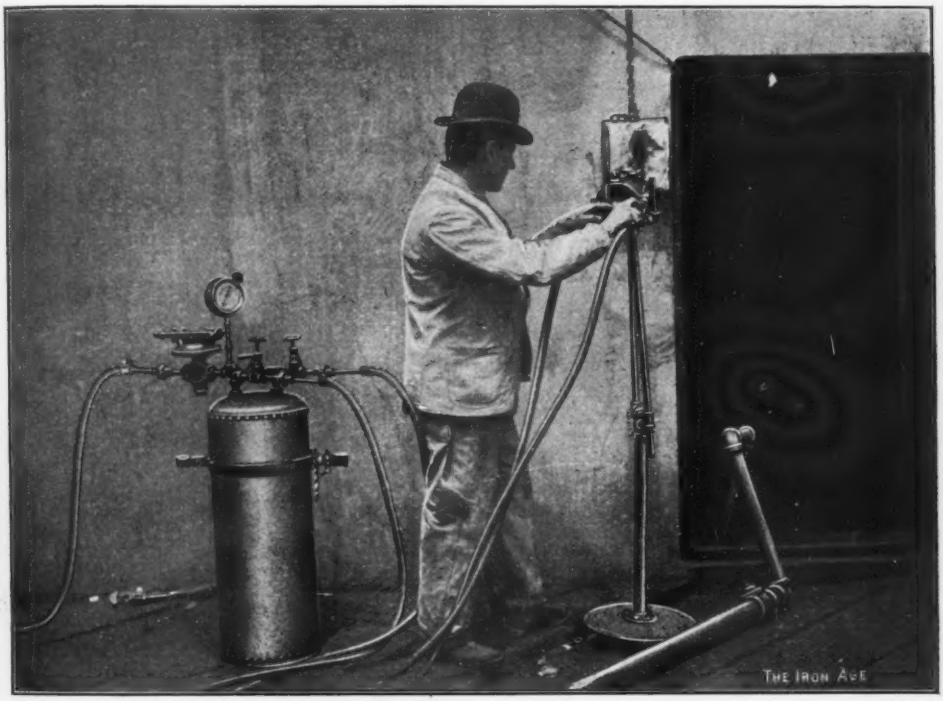
As it is true that nothing leaves the earth, and that there is more carbon in the air than beneath the earth's surface, it does not seem that there ever needs to be a fuel famine. Future inventors will probably find a means to rob the air of its carbon. There are also other fuels than carbon. Water by weight is one part oxygen and eight parts hydrogen. If these two gases are separated and again brought together and ignited, enormous heat is the result. To separate the water into these gases with our present knowledge, costs more than the value of the heat so obtainable, but some day an inventor may discover how to do it for a less cost than the value of the heat so obtainable. Such a discovery would soon make the inventor a billionaire. We are living in a very wonderful age, and for that reason anything may be expected.—JOSEPH MISKO, M. E.—*Electrical World.*

The Tynan Annealer and Rivet Heating Forge.

Many uses will be found for the Tynan annealer and forge in repair and regular ship work, and also in particular classes of work in boiler, copper and plate shops, steel car work, bridge building and the like. This device has shown its efficiency in railroad repair shops for straightening bent sills and sides of pressed steel cars, straightening damaged steel body and truck bolsters, arch bars, truss rods, etc. The entire outfit is of a strictly portable character, so that it can be used in any desired position or location.

The first engraving shows the annealer applied for annealing the armor plate of a battle ship to receive the armor door hinges. The general arrangement of the parts is illustrated in the drawing, Fig. 2. The oil supply tank may be carried upon a small truck or placed near the work, as shown in Fig. 1. The air pressure is taken from a general or special pneumatic plant, and is allowed to pass through an air pressure reducing device, thus serving the precise amount of air required for economical combustion. Regulating devices are also used for controlling the supply of air and oil at the combustion nozzle. When a pneumatic pressure service is not convenient a small hand pump will serve the purpose equally as well, an auxiliary air receiver of suitable size being the only detail required to form a portable air power plant.

The burner can be directed at any point, and the localizer or concentrator, which is composed of a special mixture of nonradiating material, while allowing



THE TYNAN ANNEALER WORKING ON ARMOR.

the flame to be concentrated on the part to be operated on, also protects the surrounding parts from the heat and prevents the spread of flame. The same burner has been applied successfully to a portable forge by the manufacturers, the Chicago Pneumatic Tool Company, Fisher Building, Chicago.—*Iron Age.*

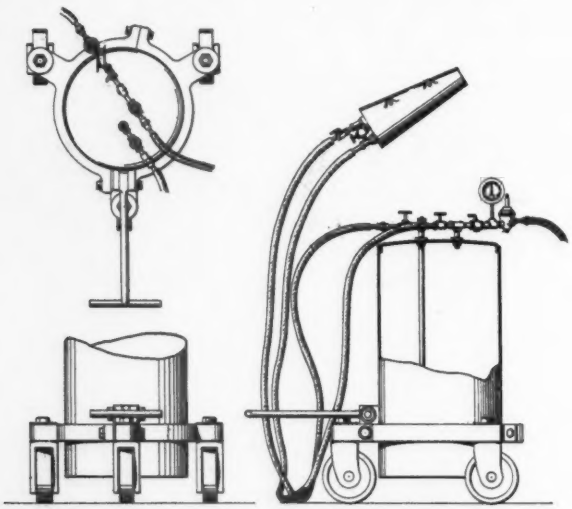


FIG. 2.—ANNEALER AS USED FOR PRESSED STEEL CAR WORKS.

Miners' Phthisis.

ITS CAUSE AND MEANS OF PREVENTION.

The *Cornish Post* gives the following report by Dr. J. C. A. Aymard, of Krugersdorp, on Miners' Phthisis, and will form an appendix to the next half-yearly report of the Government Mining Engineer:

"It is hardly possible to come in contact with the mining community at the present time without realizing the great anxiety which exists as to the prevention of this serious complaint. This apparently was not so before the war, but may possibly lapse into a similar state if the opportunity is not at once grasped.

"In order to properly combat any disease it is of the first importance to become thoroughly acquainted with its pathology (with the conditions found after death microscopically and otherwise). This is particularly true with regard to such a 'mechanically' produced disease as miners' phthisis. We know very little indeed about the actual condition of the lungs; there is no single specimen or record in Johannesburg Hospital, and I fear the whole evidence in the hands of the medical men of the Rand amounts to very little. A natural prejudice exists against post mortem examinations on white men, but it is not too much to say that many opportunities have been lost, especially in the case of blacks. The disease will have to be temporized with until the evidence accumulated by the pathologist of the commission shows us the actual conditions we have to deal with. It is not sufficient to only have evidence with regard to the lungs; every organ of the body must be properly examined, but more especially the heart.

"It is held by some of the highest medical authorities that a preliminary bronchitis lays the foundation for this complaint, and that until the cilia (or minute hair-like bodies lining the air passages) have been destroyed, dust does not enter the lung tissues. It matters little whether this is so or not. The dust may of itself

cause bronchitis in the first instance, or, which is much more certain the inhalation of poisonous gases, or again these two causes may both run concurrently.

"It is only necessary for a miner to inhale and retain one grain of dust a day to accumulate ounces in the course of years, and the evidence is wanting to show that a miner's lung becomes a block of cement. It must not be concluded that I look lightly upon the inhalation of dust. I do not. I consider it a very serious factor in the production of this disease. I also think a very small amount permanently retained and lining the lung tissue to be quite sufficient. What I do suggest is, that the amount popularly thought to exist in the lung is greatly in excess of what will be found. The great point which I think most medical men are agreed upon is that damage, permanent and ultimately proving fatal, results from the inhalation of poisonous gases, caused by blasting.

"The dust produced by rock drills, if carefully examined, will be found to largely consist of extremely fine particles, so small that they can easily pass into the bearings of a Theodolite. This dust is described by some as cutting its way into the lungs. I doubt it, and should not be surprised to find that it is actually carried to distant parts in the blood itself.

"Is miners' phthisis produced in Cornwall, America and Australia? Is it similar to the disease on the Rand? I can only say that I have heard such conflicting evidence from men who have lived in all these places that I do not feel disposed at present to risk an opinion. This is a question which the Commission would be wise in investigating.

"We know that nitrous compounds are formed after blasting, but as to their relative quantities, together with other noxious gases we have little to go upon. This indeed is where the Commission can do good work. We want the actual facts; samples of air must be taken in various places after complete and partial explosions, and these must be carefully analyzed. The air should be the ground which gives rise to so much dust and gas disturbance. The results of laboratory experiments do not give us what we want. The conditions are probably very different on the spot.

"Miners should realize that it is not only when bronchitis is caused by gas that damage is done, but that, however, produced, it has its serious influences. Men leave their work in their sodden clothes saturated with perspiration and damp, covered in dust, frequently taking their meals in this condition, and almost always thus returning to their rooms. This should be stopped by law. In some mines an effort is made to counteract this evil, but it should be universal.

"I would suggest that close to every shaft a drying room be erected in charge of a competent man. The moment a man leaves the shaft he hands his overalls to an attendant, whose duties are to place them in a steam drier, a matter of a few minutes; then by exposing them to the air they are fresh and dry when wanted. In this room there should be hot and cold water giving every opportunity for the miner to wash.

"When the above reforms have been carried out it will be possible for doctors to see almost at a glance the condition of these men, and many lives will be saved."

The *Daily Chronicle* writes on this same subject as follows:

"The constitution of the Commission to inquire into and report on miners' phthisis has been very severely criticized here. The predisposing cause of the disease, as is well known, is inhaling the sharp angular dust particles arising from the blasting and drilling of the rock, and also the lack of proper ventilation in the mines. So far, this is comparable with similar diseases at home—for instance, steel-grinders' phthisis, stonemasons' phthisis, and tin-miners' phthisis—but there seems to be considerable difference between the miners' phthisis in the Transvaal and that at home. It appears to be the impression of the people on the mines, firstly that it attacks younger men, and, secondly, that the life of the patient when he is attacked is curtailed to a greater extent than in England. A considerable number of young and healthy men are brought out from Europe to work on the mines, and these, of course, on account of their youth, should have a long span of useful work in front of them. But if the reports are anything like accurate, the number of these men who survive five or ten years' rock drilling seems to be but small. Even if they do not get the disease in a fatal form, they are compelled to turn their attention to other kinds of work, as they become incapacitated for

rock drilling. The importance of the existing state of affairs is enormous, firstly to the men themselves, secondly, to the mines, and thirdly to the general community.

"To the men—A rock driller is a skilled laborer; he therefore has had to undergo a training. In the ordinary course of events he expects to obtain a fairly high rate of wage until his working days are over, instead of which he finds after a period of say five years he has two alternatives, either to continue his work of rock drilling and look forward to the inevitable early death at the end of another five years, or he must seek some other occupation, for which he has probably no special training, and which therefore commands a much lower rate of pay.

"To the mines—The result of the men becoming sick is that the mining authorities have constantly to employ new series of less experienced rock drillers, which must necessarily affect their progress.

"To the general community—The mines being the mainstay of the country, and as at the present juncture their progress is retarded, it will naturally follow that South Africa itself will also be retarded. And further, the conversion of the wage-earning young man into an aid-requiring pauper is a very serious consideration to the remainder of the community.

"Miners' phthisis, until proved to the contrary, must be assumed to be a preventable disease, or in any case one that is capable of reduction. However, the amount of our knowledge is inconsiderable when compared with the amount of our ignorance on the subject, and it is only by a very thorough investigation of the disease and the conditions that a sufficiency of knowledge will be gained to enable the miners to work under circumstances which will not render their occupation 'dangerous.' To this end the Commission has been appointed, and it is concerning its constitution that the criticism has been very severe by those having the interest of the mines and the miners at heart. It would seem to be an axiom that whenever a Commission is appointed on a question such as this the list of members should include the name of at least one scientist. On the first Commission on Tuberculosis at home the list of members included Professor German Sims Woodhead and Professor Sydney Martin, and on the second Commission on Tuberculosis Professor John Macfadyen and other scientists were serving. These are especially named because in addition to their general scientific knowledge each had been previously engaged on the investigation of tuberculosis. The Royal Commission on Sewage included amongst its members Professor Boyce and Dr. Houston, both gentlemen of high scientific attainments who had had a considerable experience of the bacteriology of sewage before the Commission was appointed. The list could be very largely extended. These Commissions are mentioned because they were upon questions not dissimilar to the question that will come under discussion in miners' phthisis, both being very scientific in their bearing, and both being of great economic value.

"It is, of course, realized that in an important Commission such as the present, which entails the sifting of so much probably contradictory evidence, and the findings of which may be of such vast communal importance, one, at least of its members should have some legal training. Good as the medical practitioners serving on it undoubtedly are, and however much experience they may have had of the disease from its clinical aspect, it is doubted if any of them would lay claim to any special scientific knowledge, or venture to call themselves scientists. Although the lay mind is not conversant with the various departments of medicine, it has not got the notion that a general practitioner is not quite the same as a pathologist, and a great deal has been heard about the pathology of phthisis. Where, then, is the pathologist? It seems strange that the Government, evidently realizing the gigantic importance of the inquiry, should have constituted the Commission on lines so different from those of other countries, by the omission of the name of a single scientist.

"At present it is unknown what power the Commission have to appoint or invite a scientific man or men to sit with them as assessors, and it is possible that this defect may be remedied. But the opinion remains that such a man should have been appointed by the Government, and not left for the invitation of the Commission. Is there no such man available in the Transvaal? It is believed there is; but if the Government think not, they still have

Natal and the Cape to draw from, and, failing these, the United Kingdom. Certain it is, however, that without the assistance of a scientist the labor of the Commission will almost certainly lack proportion—which is expected when a Commission is appointed on a subject of such vast importance."

The Making of Liquid Air.

A great deal of nonsense has been written about liquid air, principally in America. It was to be the power of the future. By its means power was to be obtained for nothing, and so on. In the lecture which he gave before the Cold Storage Association recently, Dr. Carl Linde, of Berlin, did good service in clearing away a good many misconceptions. It would not be economical to employ it in cold storage work, he explained, because when you only require a temperature a few degrees below the freezing point of water, it is not economical to produce a temperature 280 deg. F. below. Power has to be expended in producing cold, and the power is roughly proportional to the degree of cold produced. Liquid air in small quantities, the lecturer observed, would be very useful, say, for cooling dining or ball-rooms. In these cases the quantity of liquid air would be so small that the high price at which it was produced would not matter. Drawings were shown of apparatus by which rooms could be cooled in this way.

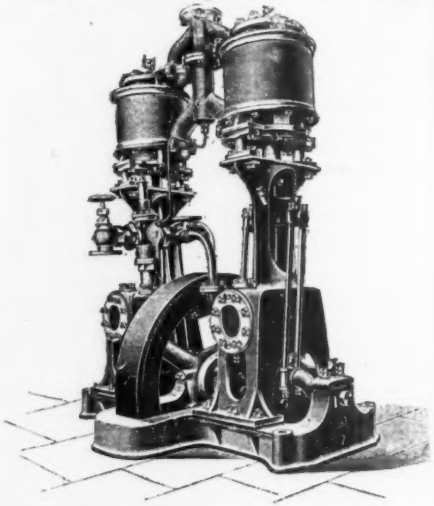
Liquid air is produced from ordinary atmospheric air, by a continuous process of compression and cooling. Every substance, it is supposed, may exist in one of three states, the solid, the liquid, or the gaseous, according to the surrounding conditions. Each state presupposes the presence of a certain quantity of heat in the substance. Thus in the solid form, a smaller quantity of heat is present, actually in the substance itself, than in the liquid form; and again a smaller quantity of heat is present in the liquid form than in the gaseous. The addition or the subtraction of heat from any substance, in sufficient quantities, will cause the substance to change its state. In addition, the three forms in which substances may exist, mean that the molecules, the very minute parts of the substances, are very much closer together in the solid form than in the liquid form, and in the liquid form they are much closer together than in the gaseous form. So that in order to liquefy a gas, two things are necessary, the closing up, as it were of its molecules, and the extraction of a certain quantity of heat from it. When air is compressed, as in those cases where compressed air is used for mechanical purposes, heat is generated in the air, in the act of compression. It represents a portion of the work done upon the air, by the compressor. And this heat has to be extracted, as well as the heat possessed by the air, in virtue of its condition as a gaseous mixture, before it can be liquefied. And so in the process of making liquid air, the air is continually compressed, by successive stages, and continuously cooled, a very pretty device being made use of in the cooling, by which the air which has been cooled to a certain degree, is made to cool air that has not reached that point, so that the effect is cumulative. When liquefaction is finally reached, the air in its liquid form looks exactly like water, and may be poured out just as water is—with certain precautions. The fact that liquid air is at the extremely low temperature named, makes it dangerous to handle, without precautions similar to those which are taken in handling hot bodies. With very cold bodies, heat passes from the hand, say to the object, at a very rapid rate, just as heat passes from a hot body to the hand, at a rapid rate. It is the rate at which the heat is transferred, either to or from the human body which causes the pain and other troubles. When poured out on a table the liquid air runs about in small globules, just as mercury does, and disappears in a very short time. It has returned to its gaseous form. When allowed to escape into the atmosphere, its presence is shown by clouds of mist, producing the impression that the liquid air is converted into fog. This is not so, however. What really happens is, the aqueous vapor which is always present in the atmosphere, particularly that of rooms in which a number of people are assembled, condenses, and then freezes, or forms a sort of hoar frost, and it is that we see, not the liquid air itself. Liquid air seizes every opportunity of returning to the gaseous condition, but it can only do so by extracting heat from surrounding bodies. When it is allowed to escape into the atmosphere, it extracts the heat from

the air into which it passes, the atmospheric air of the room, in the immediate neighborhood of the orifice from which it is escaping. This lowers the temperature of the air at that point, and with lowered temperature it is no longer able to maintain so much aqueous vapor in suspension. The vapor is deposited as water, and then freezes. The same action, in a minor form, may be seen in any cold storage engine house, where the cold pipe is covered with snow.

The method adopted for storing liquid air, devised by Professor Dewar, is one of the most novel arrangements that has been seen in the domain of physics for a long time. The air is stored in glass bottles, each bottle consisting of two distinct bottles, separated by a vacuum, maintained at as high a figure as it is possible to obtain. In addition, the outside of the outer bottle is silvered all over with mercury. The object of the arrangement is to prevent the access of heat to the liquid air inside the inner bottle. The vacuum space offers a very high resistance to the passage of heat waves through, or across it, and the mirror formed by the mercury on the outside of the outer bottle reflects the heat waves away from the bottle. The mouth of the bottle is left open to the atmosphere, and it was stated by Dr. Linde that a charge of liquid air would last for about fourteen days. During this time the charge is slowly disappearing by evaporation, by reconversion to the gaseous form, from the passage of heat to the liquid. Closed bottles cannot be used, as, it being impossible to exclude completely heat from the liquid air, the latter would be slowly changing into the gaseous state, and in so doing, creating a pressure within the bottle which no vessel could withstand, which would also resist the passage of heat through its walls. The final pressure was given by Dr. Linde as 12,000 lbs. per square inch, when all the liquid had returned to the gaseous form. This is the reason why steel bottles cannot be employed as they are for carbonic acid gas, ordinary compressed air, and so on.—*Globe*, London.

Double-Acting Air Compressors.

We illustrate herewith a pair of vertical double-acting air compressors, recently manufactured by the Pulsometer Engineering Company Limited, of Nine Elms Ironworks, Reading, and intended to supply a large volume of air at a small pressure of, say, 25 lbs. The plant consists of two separate compressors, each combined with its own engine, the steam cylinder, with its guide and valve chest, being cast in one piece with the main

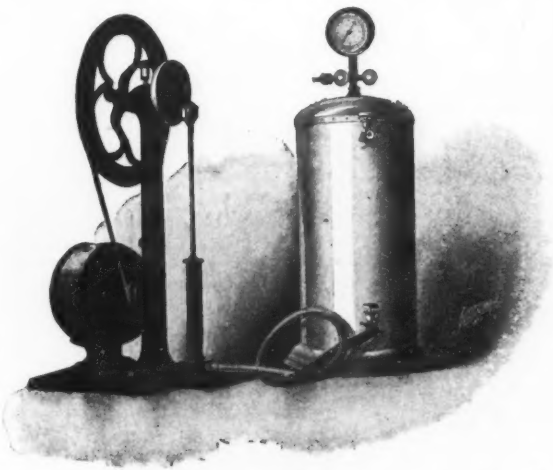


DOUBLE-ACTING AIR COMPRESSORS.

frame. The compressor is directly driven, two side rods being used, each coupled up to crank placed below the steam cylinder. The valve gear is driven from a separate crank, and is of a modified "Hackworth" type, which gives a very satisfactory steam distribution. The steam cylinders are each 7 in. in diameter by 9 in. stroke. One plant can be run independently of the other if required. The compressors, which are double-acting, 10 in. in diameter by 9 in. stroke, are placed above the steam cylinders, being carried on two wrought-iron standards. The valves and seats are renewable, and the compressor is water-jacketed. Both engines are mounted on one continuous bed, making the whole plant entirely self-contained. An automatic arrangement is fitted, so that when the required pressure is obtained in the reservoir, the plant stops automatically, starting again as soon as the pressure falls 2 or 3 lbs. The plant is fitted up in the company's usual high-class style, and is a thoroughly mechanical job in every way. —*Mechanical World, London.*

Dental and Surgical Air Pump.

The accompanying cut shows an electric air compressing outfit for use with atomizing tubes in treating mouth, throat and lung diseases, and which is also adapted for dental purposes, such as cleaning cavities in teeth. The outfit, as shown, consists of a single-action piston air pump with metallic ball valves operated by an electric motor, connected by two feet of pressure hose to a 6-gallon nickel-plated tank, which is supplied with a gauge to show the pressure, and stop-cocks and hose connections for leading off to the atomizing tubes, etc.



THE "EMERSON DENTAL AND SURGICAL AIR PUMP."

The pump can be started with the maximum pressure in the air tank. A small air valve is furnished at the bottom of the pump, and when it is desired to start pumping when pressure is on the tank, this air cock should be opened until the motor reaches speed. As soon as the motor reaches speed, close this air cock and the air will be delivered into the tank without stopping the motor.

This pump will compress air up to about 50 lbs. pressure, but is more efficient up to about 30 lbs. pressure, which, we understand, is usually sufficient for this class of work.

The pump has a capacity of about 1½ gallons of free air per minute, and will pump the 6-gallon tank, as shown, up to 10 lbs. in 2½ minutes; 15 lbs. in 4½ minutes; 20 lbs. in 6½ minutes; 30 lbs. in 10 minutes; 40 lbs. in 15 minutes; 50 lbs. in about 20 minutes.

This style of outfit is not only much more convenient than any water pressure air pump, but in most cases will cost very much less to operate, and has the additional great advantage of being able to get the pressure anywhere that it is desirable, and no permanent fixtures are necessary for fitting up this outfit, as all that is necessary to start it in operation is to plug in the lamp socket the same as an electric lamp or an electric fan motor.

The cost of operating such an outfit is hardly worth considering, as at the ordinary rates charged for an electric light current of 20 cents per 1,000 watts, it would cost less than one-fourth of a cent to pump this tank of air up to 20 lbs. pressure.

All of the parts of this outfit are extremely simple and durable, the pump having long, heavy bearings, and the valves being metallic, the only part of the pump which might require renewal after a considerable length of time being the leather packing of the piston, but this can be replaced by anyone in a very few minutes, and at a cost of a few cents.

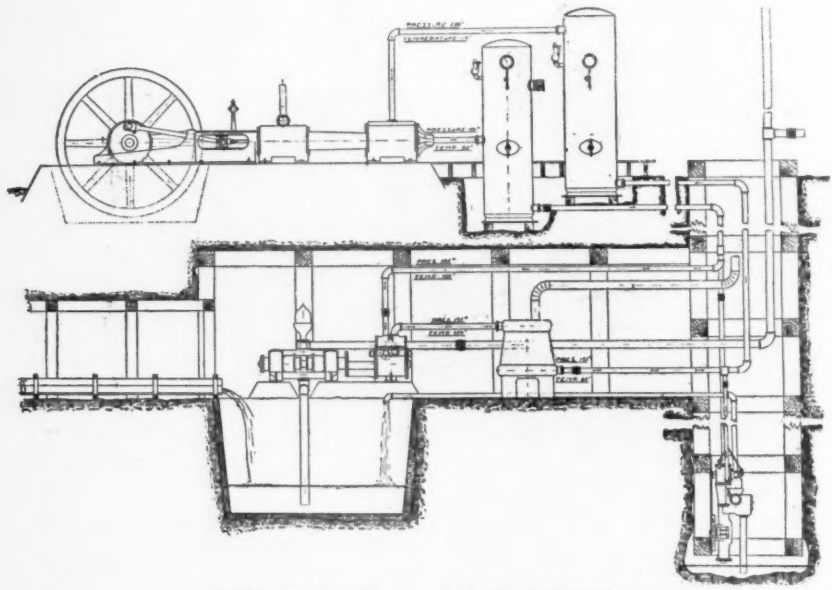
The motor is our regular type of small

power motor, which has a half-inch shaft, and for such a use as this, will practically last forever. In ordering, great care should be taken to give the exact voltage of the current on which it is desired to use it, and in addition to this the number of alternations per minute of the current, if for use on alternating current circuit.

The "Dense Air" System of Power Transmission in Deep Mine Pumping.

There has been recently installed at the Bisbee West Copper Mining Company's shaft No. 1 a pumping plant using air as a means of power transmission. This plant was installed by the John Wigmore & Sons Company, of Los Angeles, Cal., and is operated under patents which they control. They have named the principles of these patents "The Dense Air System of Power Transmission." This dense air system has as its object the use of the difference in pressure between two confind air bodies. A compressing engine is used to maintain the greater pressure by raising that of the low-power body of air and delivering it to the high-power body. In operation the low-pressure air is sufficiently above atmospheric pressure and sufficiently cool to allow of an economic line of compression in reaching the high pressure. The general scheme of the system is shown in the accompanying drawing.

Following is a brief description of the machinery employed in the Bisbee West Plant. Steam is supplied by a 60 horse power horizontal return tubular boiler burning fuel oil. This boiler supplies a 30 horse power hoist, and the air compressor of the pumping plant. The main compressor is one built by the Ingersoll-Sergeant Drill Company, and is one of their standard straight-line type, with the exceptions that the air end was built a little heavier than usual, and that the piston inlet was enclosed in a bracket fitted for pipe connection to the return system. The steam cylinder of this compressor is 16 inches in diameter by 18 inches stroke, and is furnished with an adjustable Meyer cut-off valve. The air



DENSE AIR SYSTEM OF POWER TRANSMISSION.

cylinder is 12¼ inches diameter by 18 inches stroke. The regular poppet inlet and discharge valves supplied by the manufacturer are used. From this compressor two lines of pipe are led to the shaft, about 60 feet distant, and then to the 700-foot level. The high-pressure line is 2½ inches diameter, while the return or low-pressure line is 3 inches diameter. In the high-pressure line is an air receiver 36 inches diameter by 8 feet, and also a reheater of sufficient size to heat the air to 300 degree F., the reheater being on the 700-foot level adjacent to the pump and the receiver on the surface near the compressor.

The low-pressure, or return line, is continuous from the exhaust of the pump to the inlet of the compressor. The pumps used were built by the Cameron Steam Pump Company, and are of their standard station and sinker types. The station pump has an air cylinder 16 inches in diameter by 18 inches stroke, and a center packed plunger 6½ inches diameter by 18 inches stroke. This pump raised the water from a sump on the 700-foot level to a tank 40 feet above the collar of the shaft, giving an average lift of 750 feet. A vertical sinking pump 10 by 5 by 13 inches is also included in this installation, but was not operated during the test given below. Its duty is to lift the water to the sump on the 700-foot level from the shaft bottom. A small compressor 6 by 6 by 6 is connected to the low-pressure return line, its duty being to supply sufficient air to overcome leakage from the pipe lines and stuffing boxes of the machines, in this manner keeping the quantity of air in the system constant. In the following test the reheater was not used. This reheater was designed to burn gasoline, but it was found that it was impossible to do so, as there was not sufficient air in the pumping station, which is very small, to support combustion. If this reheater could have been used the efficiency of the plant would have been at least 20 per cent. better than that shown by test. In the following table will be found the average results of a series of tests of this plant made September 14, 1902:

Duration of tests.....	1 hour each.
Average steam pressure at throttle of compressor	81 lbs.
Total steam used by compressor	802 lbs.
Average R.P.M. of compressor	52.3
Average R.P.M. aux. compressor	20
Average R.P.M. pump..	39.8
Average pressure: inlet to compressor.....	83 lbs. gauge.
Average pressure: discharge from compressor	158 lbs. gauge.
Average pressure: inlet to pump	152 lbs. gauge.
Average pressure: exhaust from pump....	92 lbs. gauge.
Average temperature: inlet to compressor....	69° F.
Average temperature: discharge from compressor	162° F.
Average temperature: inlet to pump.....	89° F.
Average temperature: exhaust from pump..	52° F.
Average ft.-lbs. per minute shown by indicator cards, steam end compressor	1,075,300
Average ft.-lbs. per minute steam end aux. compressor	22,300
Total average ft.-lbs. per minute shown on steam end of compressors	1,097,600
Average ft.-lbs. air end compressor, as shown by indicator cards..	1,045,100
Average ft.-lbs. air end auxiliary compressor.	19,500
Total ft.-lbs. air end of compressors	1,064,600
Total water pumped...	833 cu. ft.
Cubic ft. of water pumped per minute..	13.88
Average lift	750 ft.
Total ft.-lbs. per minute in water pumped.	649,584
Efficiency of ratio between ft.-lbs. of work in air cylinder of compressor and air cylinders of pump.....	70.6 per cent.
Efficiency or ratio of ft.-lbs. shown by indicator cards on steam end of compressors and ft.-lbs. of work in water actually pumped	59.2 per cent.
Duty or ft.-lbs. of work in water pumped per 1,000 lbs. of steam used, .4.....	8,600,000

From this test it is very readily seen that the efficiencies are exceptionally high for a deep mine pumping plant.

One incident in regard to this plant showing its adaptability to deep mining operation occurred September 20. The supply of fuel oil was exhausted, and there being no other fuel obtainable, it was necessary to shut down the plant. Before more fuel oil was secured—a matter of

three or four days—the water had risen in the mine almost to the 200-foot level, putting the pump about 500 feet under water. When the boiler was fired up and the compressor started, the pump started with the compressor, as was shown by the water from the discharge pipe. It required about 48 hours of continuous running to pump the water down to the pump level. During this time the pump worked under water at its greatest capacity and continuously.—D. A. McNeill in *The Engineering and Mining Journal.*

Chain Coal Mining Machines Operated by Compressed Air.

The first breast type of coal cutting machine was brought out by the Jeffrey Manufacturing Company, of Columbus, Ohio, and as one now looks back on such early machine and compares it with the chain coal cutter as now manufactured by that company, he is impressed with the great strides that have been made in coal mining machinery during the past twenty years.

AIR CHAIN COAL MACHINE.

The early efforts resulted in a machine having upright engines attached to a moveable carriage or bed-plate, to the front of which was attached a frame, on the extreme outer end of which was supported a round bar, designated as a cutter-bar, the surface of which was covered with small tools steel cutters. This bar was supported in suitable bearings, and power was transmitted from the engine shaft to this bar by means of an endless steel chain. The engine, carriage, moving frame and cutter-bar were all fed forward in an outside stationary frame by means of a screw, the depth of undercut depending upon the length of the frame. On the outside of stationary frame were placed light chains with suitable wings attached for the purpose of bringing back away from the face of the coal the small particles of coal or cuttings which were displaced by the revolving cutter-bar. The width of the cut was about thirty-six inches, the depth of the cut varying from five to seven feet, and the kerf removed about four inches. It would make an interesting chapter in the history of coal mining if the failures, break-downs, and obstacles which were met with by the manufacturers and users of this early machine could be recorded. This first machine was built with the one idea constantly in mind ot keeping the weight down to the minimum, and as a result the machines went to pieces just about as fast as they were put up against the coal.

An amusing incident has been told of a test run which was made in the presence of a prospective buyer of one of these early machines. A miner had been employed to operate one of these machines and to try to make a success of it. His faith in the machine far exceeded the merit of tne machine as shown in actual service. He had been for weeks struggling to make the machine work successfully, and was finally able to make one single undercut. After finishing this one cut he received from his employer a telegram, advising him that one of the largest operators in the country was going to visit the mine to see this machine in operation, with the idea in view of adopting it throughout his properties if an examination satisfied him as to its practicability. The miner was in distress, but finally decided to pack the kerf of the one cut which he had succeeded in making with the fine particles of coal which had been removed, set the machine in the position in which it had made its original cut, and await the visit of the operator. His deceit worked like a charm. The machine buried

its cutting frame in the fine cuttings and finished its run without a mishap. The operator was won over to the great future of the mechanical coal cutter and the necessity for all up-to-date mines to be equipped with the "Iron Miner." It is of interest to note that this same operator has been since that day a constant user of the breast type of machine, and perhaps has been the very largest user of coal cutters in the country.

The Jeffrey Manufacturing Company kept hammering away in the face of almost unsurmountable difficulties, strengthening the parts which proved weak, altering from time to time the different feed and pull back mechanisms as defects developed, lowering the engines down close to the frame of the machine, making it possible to adopt the machine in the tninner veins of coal, and in fact departing very largely indeed from the original idea as to form and construction, until they finally made the most distinct step toward the perfecting of the machine by changing from the cutter-bar type to the chain type. This change, it was found, immediately reduced by over one-half the power required to cut the coal. An illustration is here shown of the chain type of air machine. We regret that we have not been able to get hold of a photograph of one of the very earliest types of cutter-bar machines having the upright engines.

Prior to the change from the cutter-bar type to the chain type of machine, the Jeffrey Manufacturing Company had developed and brought out the electric motor to take the place of the air engines on the machine. There are to-day a number of mines throughout the country where it has been found desirable, on account of gas and other peculiar local conditions, to use the air machine in preference to the electric so that the 16-D air chain machine is still manufactured in large numbers.

Compressed Air as Transportation Agent.

The *Scientific American* contains in its special "Transportation" number an article by Mr. Waldon Fawcett on compressed air locomotives from which the following has been taken:

"With a more extensive use of compressed air for power purposes has come a corresponding broadening of the scope of its employment as a transportation agent, and indeed it has been conclusively proven that pneumatic traction has decided advantages over all other forms of mechanical haulage for a large variety of operations. Prominent among these are the various phases of underground haulage. For coal mines where there is danger from mine gas its utilization is almost essential, whereas the advantages which commend its employment in non-gaseous mines are almost as potent. A rather unique field has been opened by the introduction of compressed air locomotives in railway tunnels, where the smoke vapor and gas from steam locomotives are objectionable.

"For the ordinary compressed-air haulage plant there are five essential features, namely, the locomotives, constructed to carry stored-up energy in the shape of compressed air, a charging station, a stationary reservoir, usually consisting of one or more storage tanks in which the air is compressed, an air compressor capable of compressing any desired number of cubic feet per minute to any pressure desired, and power for operating the compressor, either steam or water power being applicable for this purpose.

"The general machinery of an air locomotive, cylinders, frame, etc.. is usually very similar to that of a steam locomotive, save that the weight is greater, the bearings larger and the details of construction stronger than in a steam machine of the same power. The main points of difference are found in the fact that instead of the usual boiler with its fuel and water accessories for developing power, the air locomotive is equipped with one or more strongly constructed main storage tanks, which are charged with compressed air at high pressure, a combination regulator and automatic stop-valve and an auxiliary low-pressure reservoir, in which the air is carried at a uniform working pressure for distribution to the cylinders. The cubic capacity and the pressure of air in the main storage tanks on a motor are determined, of course, by the amount of stored energy required by the length of the run which such a locomotive is to make and the weight of the train which it is called upon to draw. Not infrequently locomotives are built to carry an air pressure of 800 or 1,000 pounds, but

relief valves make it impossible to charge the motor tanks to a higher pressure than is required. The initial storage pressure decreases, of course, while the locomotive is working. As illustrating the capabilities of the compressed air motors, it may be mentioned that there are in service in this country a few locomotives which are fitted with seamless, steel tubes and carry a pressure of from 1,500 to 2,500 pounds per square inch.

"For charging the locomotives storage tanks previously referred to, there are provided the charging stations, which are connected with the stationary receiver or reservoir by a pipe. It is customary, when the reservoir or storage system is a pipe line, to have a charging station at each end of the line, so that the motor may take a charge of air at the end of each single trip or each round trip as required. Air locomotives may be charged either direct or by reservoir. However, direct charging is very wasteful, and consequently the method most generally accepted involves the use of the stationary reservoir.

"The reservoir for a compressed-air transportation line usually consists of either a pipe line or one or more storage tanks of construction similar to the locomotive storage tank, although usually designed to carry a somewhat higher pressure. By means of the reservoir system the compressor may be kept in nearly continuous operation at a fairly uniform speed. By an automatic system of governing the compressor, when the work is light, slows down in speed, whereas when the demand for air increases, the speed is quickly brought up to the required capacity."

Priest Snow Flanger.

The flanger is attached between the front truck wheel and the pilot, and is supported directly on the truck. The effect of this is to give a very slight motion to the flanger across the track in passing around curves, thus enabling the flanger to be constructed so as to cut the snow close to the rail, cutting about 2 inches deep on the inside and 1 inch on the outside. The flanger being supported directly by the engine truck does not rise and fall by the movements of the engine on the springs, thus enabling a deep cut to be made, and at the same time maintaining a uniformity.

The knives are placed about 1 inch above the rail, which avoids all friction and wear, and enables the use of torpedoes with no danger of their removal by the flanger.

These knives are strongly built so that they will cut the hardest snow. The knife proper is attached by means of bolts to the wings so that in case of an accident nothing but the knife will be injured, and any engineer can easily remove the knife and replace with a new one.

It is operated by means of an air cylinder controlled in the cab.

This flanger can be used with perfect safety on all trains. It is properly located, gives clean rails for all wheels, leaving no snow to absorb power by contact.

Prevents derailments caused by engine truck wheels mounting hard-packed snow or sand.

Costs nothing to operate; in charge of and controlled by engineer; run by compressed air.

Daily use of flanger prevents formation of hard flanges, making line always passable for hand-cars, facilitating the work of section men instead of increasing it by flanging by hand.

Preserves full tractive power of locomotives, preventing loss caused by intervention of snow and ice between driving wheels and rails.

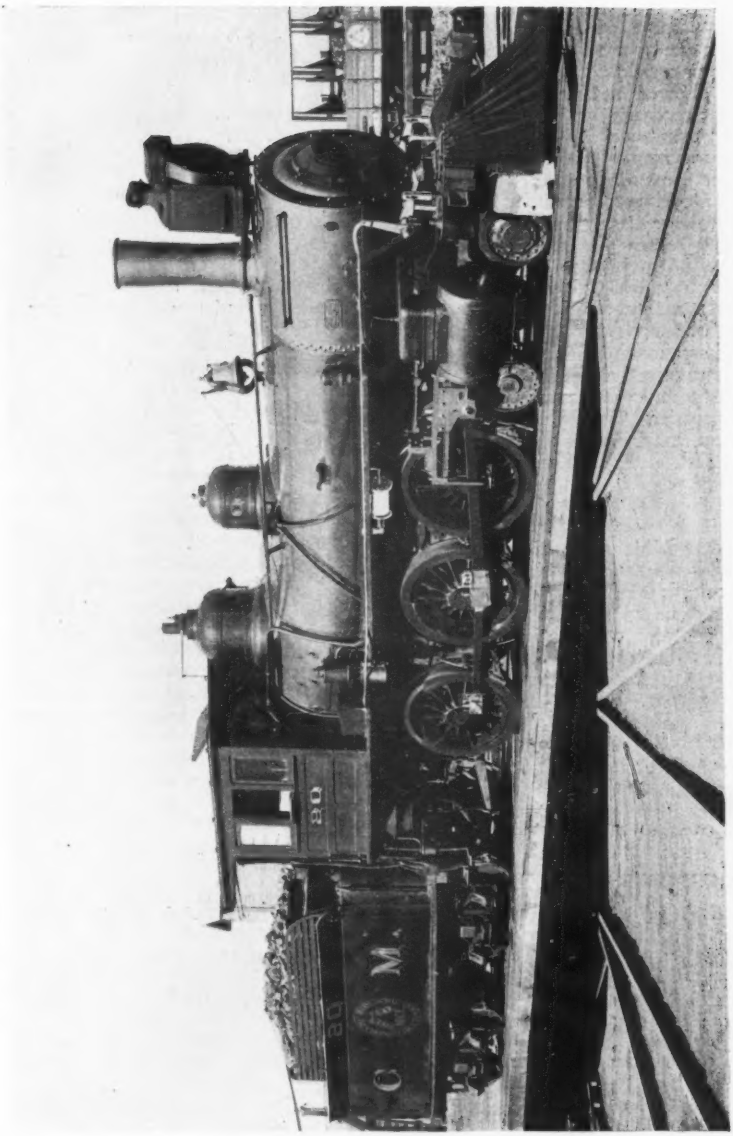
Avoids rail and tire cutting by slipping on snow.

The flanger is not unsightly, being behind the pilot and out of the way.

A pilot plow of any size desired can be carried in the usual manner.

A passenger train equipped with the Q and C-Priest Flanger will readily run through 10 inches to 12 inches of hard-packed snow and sand. A freight engine will pull its usual winter load under same conditions with but slight reduction of cars.

These flangers are now being used on more than thirty railroads in the United States.



LOCOMOTIVE FITTED WITH PRIEST SNOW FLANGER.

Doubling the Efficiency of Compressed Air.

In the volume of the *American Machinist* for the year 1898, at page 219, will be found an article with the above title in which I showed the promise of largely increased economy in compressed air power transmission by the use of the dense air or return pipe system. In this system the same air is used over and over (a small auxiliary compressor making up for the leakage) and the pressure in the exhaust or return pipe is maintained far above the normal atmospheric pressure. In the example which I considered in the article referred to, the assumed working pressure was 200 pounds gage, and the exhaust pressure 100 pounds. Theoretically the system promised a great increase in efficiency, and this has since been realized in practice. Several applications of the system have been made upon the Pacific coast and all have shown most satisfactory results.

I am enabled to present here some data from an installation of this system at the Bisbee West Mine, near Bisbee, Arizona. The plant consists of the following: One Ingersoll-Sergeant Straight-Line air compressor, steam cylinder 16 inches diameter, air cylinder 12¼ inches, stroke 18 inches; one Cameron station pump, air cylinder 16¼ inches diameter, plunger 6½ inches diameter, stroke 18 inches. A 6x6x6-inch auxiliary air compressor is connected to the low-pressure pipe line to supply leakage in pipe line, thus keeping the pressure constant at any desired point. The duration of the test here recorded was 70 minutes:

AVERAGE TEMPERATURES.

	Degrees F.
Inlet to compressor	69½
Receiver	162
Inlet to pump	88.8
Discharge from pump	51.6
Station	72
Engine-room	93

GAGE PRESSURES.

	Pounds.
Inlet to compressor	83
Discharge from compressor	158.3
Inlet to pump	152.6
Discharge from pump	90.9

MEAN EFFECTIVE PRESSURES IN CYLINDERS.

	Pounds.
Compressor	65.6
Pump	61.7

SPEED.

	R. P. M.
Compressor	56.35
Pump	19.9
Auxiliary compressor	98.7

WORK.

Total indicated foot-pounds in air cylinder of compressor per minute	1,268,400
Total indicated foot-pounds in air cylinder of pump, per minute	751,500

The power thus indicated at the pump is 59 per cent. of that of the compressor cylinder, while with the usual compressed air practice in driving a steam pump in this way it is rarely that more than 25 per cent. is realized.

This plant is criticised for its deficiencies by the operator of another dense air plant, where a rock drill is operated instead of a pump. The drill is 1,800 feet from the compressor, and there are two lines of 2-inch pipe 1,300 feet long and two lines of 1½-inch pipe 500 feet long. The working pressure is from 215 to 220 pounds, and the return pressure 95 to 100 pounds. Notwithstanding that it is much more difficult to keep the piping around a drill tight than it is around a pump, the auxiliary compressor to make up the leakage is not run more than a quarter of the time. The compressor in this case, with air cylinder 5 inches diameter by 9 inches stroke, runs 90 to 95 turns per minute, and besides driving the 2¾-inch rock drill in "the hardest rock I have ever seen" it also runs a 5x6-inch slide valve engine eight hours a day to drive a blower, and pumps 8,000 gallons of water 200 feet high. The joints of the pipes in this case were made with shellac, which the engineer claims accounts for the small leakage. He also suggests that the pipes at the Bisbee West mine are too small, being 2½ and 3 inches instead of 3 and 4 inches, the latter of each of course being for the exhaust.

I regret the crudeness of the information here given, but it still seems clearly to show that, both theoretically and prac-

tically, there is much to be saved by the adoption of this system wherever there is any permanency of installation. The above data came from Mr. F. H. Wheelan, president of the Pneumatic Power Company, 224 California street, San Francisco, Cal.—FRANK RICHARDS in *American Machinist.*

Electrical Equipment Manhattan Elevated Railroad.

In January, 1902, the *Railroad Gazette* described the new electrical equipment on the Manhattan Elevated Railroad, New York City. One year has passed and the system is nearing completion. Difficulties have developed, but most of these have been met and the indications are that within a short time the entire system will be working smoothly.

COMPRESSED AIR'S interest in this railway rests on the use of the air brakes.

Each of the motor cars on the elevated line is equipped with an electrically-driven air compressor for working the air-brake system. Each compressor consists of a motor, about 5 h. p. direct connected to a two-cylinder direct-acting air pump without gears. Each compressor is controlled by an automatic governor which maintains the proper air pressure in the storage tank. The Westinghouse quick-action automatic brake is used, giving much quicker retardation than the vacuum brake, thus allowing speed to be held longer.

The complete motor and controller equipments, as well as the air compressors and their governors, were designed and built at Schenectady by the General Electric Company, this being the largest single order ever placed for electrical apparatus.

The eight motors on one six-car train weighing with passengers 154 tons will, on a level track, bring the train up to a speed of at least 15 miles an hour 10 seconds after starting from the station, which is over twice the speed that the steam locomotives can reach in the same number of seconds with a five-car train. If allowed to run up to full speed the electric trains will reach 40 to 45 miles an hour on a level track.

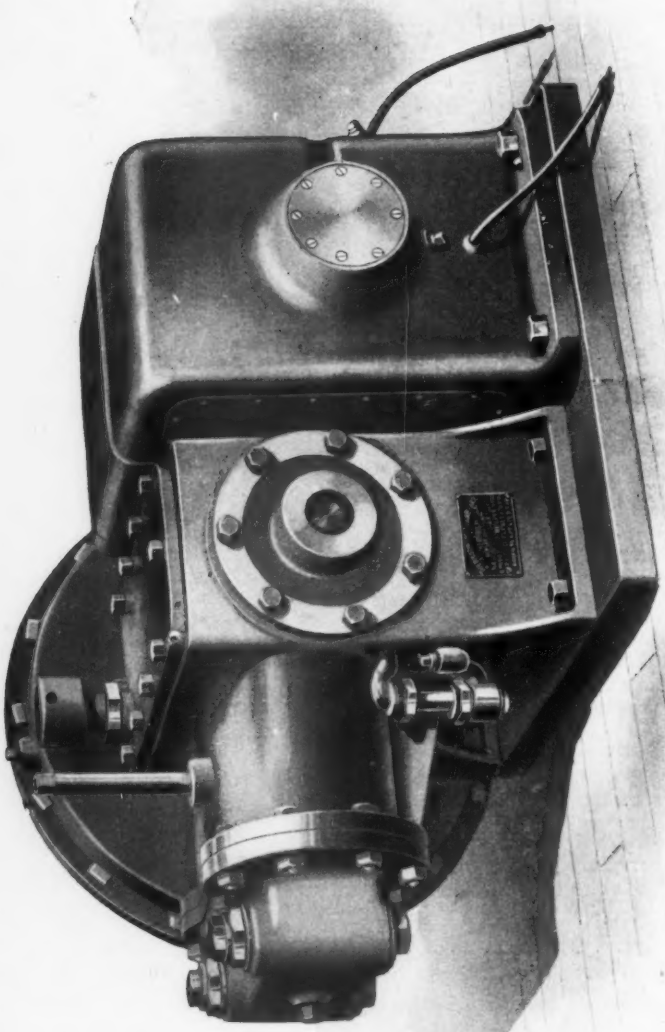
The motorman controls all eight motors on the four motor cars of a complete six-car train with one controller, much smaller than the controller of the ordinary street car. Each of the motor cars is fitted with the General Electric Company's train control. Each motor car is fitted with a master controller at each end, so that a train of any number of cars may be reversed at the end of the route without switching.

The generating station occupies the block bounded by Seventy-fourth, Seventy-fifth, the exterior streets, and the East River. All current is generated there, the plant having a maximum capacity of 80,000 h. p. The main building is divided by a longitudinal wall into two parts; the boiler plant and accessories occupying one-half and the engines and dynamos the other.

Westinghouse Electrically Driven Air Compressor.

A growing demand exists for electrically driven air compressors adapted to supply compressed air for car brakes and train signals as well as for various other industrial uses.

To supply this demand the Westinghouse Air Brake Company has designed a motor-driven air compressor, which consists of a pair of parallel cast-iron cylinders in which are trunk pistons connected to a crank shaft. The cranks are spaced 180 degrees apart, so that as one piston commences its forward stroke the other begins its return; thus the pistons constantly move in opposite directions and produce a continuous and uniform thrust on the shaft. The pistons are single-acting; that is, the air is compressed only on the forward stroke. The axis of the crank shaft is located below a plane through the axes of the two cylinders in such a way as to minimize the angularity of the connecting rod during the forward or working stroke, and by this arrangement the wear of the cylinder and piston is largely decreased. The crank shaft is of cast steel, connected to the motor directly by a gear and pinion. The valves, made of machine steel, are, in form, a successful modification of the



WESTINGHOUSE ELECTRICALLY DRIVEN AIR COMPRESSOR.

simplest check, and, while meeting every demand of the most severe service, requir little or no attention. Placed vertically, they operate without springs, and can be very easily removed or replaced without disturbing any other part. Particular attention has been given to reducing the cylinder clearance to a minimum; and, as a result, this clearance is so small that an unusual efficiency, approximating 80 per cent. of the theoretical displacement, is obtained. The pistons are of cast iron, fitted with improved packing rings which prevent any undue leakage of either air or oil. The cylinder head, including valves, can be easily removed, and ready access to the pistons secured. The teeth on the pinion and gear are of the helical, or "herringbone," type. This style of gearing has proved to be durable and best adapted to operate with the least possible amount of noise.

The Tunnel Hospital.

The strangest hospital known is that which is being maintained to-day in Jersey City for the benefit of the Hudson River tunnel workers.

The "hospital" is fitted up on the tunnel company's grounds for the treatment of those who collapse while working in the compressed air of the long black hole.

The work has to be carried on under atmospheric pressure far exceeding the normal pressure on the earth's surface of fourteen pounds to the square inch. The abnormal pressure is bad for most men and fatal for some. Men working under such conditions are attacked by a strange disease known as "the bends." Many, too, go down with heart failure.

To allow men who collapse to be brought immediately into the normal atmosphere would in most cases be fatal. This explains the company hospital.

It is not a hospital of the ordinary kind. It consists of a huge cylinder, like a locomotive boiler without the tubes. It is fitted with air pipes and valves, by which the atmospheric pressure can be regulated. It is also fitted with a cot, on which the victim of an accident or of the "bends" may be placed.

When a man is overcome he is removed through the various air locks slowly, and then, with a companion, is sent up the shaft and immediately taken to the "hospital." He and the man who accompanies him are admitted and the air is turned on. It is compressed to the proper degree and then the pressure is gradually reduced and the victim allowed to become accustomed to it until it is down to the normal, when he can with safety go out into the open air. This treatment takes hours of time.

Of course, there are other features of the treatment, but the main principle of the hospital is the compressed air.

Dr. A. J. Loomis is in charge of the hospital and he is kept busy with the many cases that come from the black hole each day.

It is said that in the heading at the New York end of the tunnel, the atmospheric pressure is so great that men can work only twelve minutes at a time.

A man stands at the lever that controls the valve with a watch in his hand and on him the lives of the men in the heading are said to be absolutely dependent.

Notwithstanding the hospital, the tunnel is not without its victims. The last was Patrick Garvey, of this city, who died recently of the "bends."

Garvey dropped dead in the ferryhouse of the Erie Railroad while he was on his way home after having undergone nearly twelve hours of most excruciating agony.—*The Chicago, Ill., American.*

Novel Engine, Which Runs by Oiled Air. Is a New Form of Motive Power.

The Diesel Engine does not operate by an explosion, as is the case with the ordinary gas or internal combustion engine or other types. There is no mixture of combustible elements in the cylinder excepting at the moment when the combustion is intended to begin. There is no explosion and there are no ignition devices of any description, the machine being a simple caloric or heat engine, using air as a medium of expansion instead of steam. Steam has received heat from the fuel at the boiler. Air in the Deisel process receives heat direct from the combustion of oil-fuel mixed with the air in the working cylinder.

The engine operates on the Otto cycle or four-stroke principle, the first stroke filling the cylinder full of air at atmospheric density. The second stroke compresses the air to about 35 atmospheres.

At the point of highest compression the air is practically in an incandescent condition. Just at the reversing point in the stroke of the piston a certain quantity of oil is sprayed through an atomizer in the shape of mist, but not vapor. This oil is immediately ignited and burns slowly through a limited portion of the stroke. The expansion of the aid and gases completes the third or working stroke, and the fourth stroke ejects the gaseous products of combustion, clearing the cylinder for a repetition of the cycle.

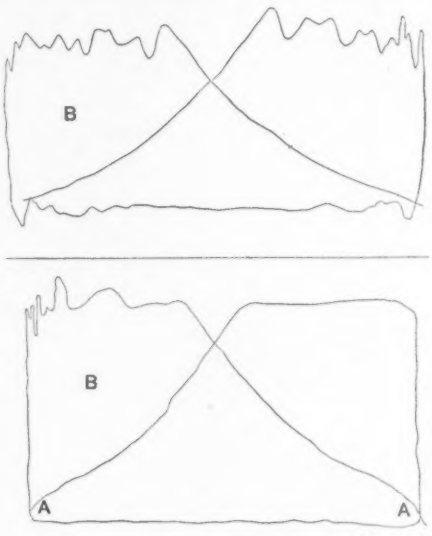
The conditions required in order to make the nearest possible approach to the perfect Carnot cycle seem to be almost ideally met in the Diesel engine, hence the results claimed for it are rational. Where the best steam plants convert only about 10 per cent. of the total heat of the fuel into work, the Diesel engine is said to convert from 25 to 30 per cent., and this in the smallest sizes as well as larger ones. Furthermore, the range of best economy extends over a large part of the entire power, whereas in the steam engine this range is limited to a very small part of the entire power.

Regardless of the size of the unit, the consumption of fuel will not exceed 0.5 to 0.6 pound per brake horse power per hour, when the engine is running within its economical range; or, more particularly speaking, a 100-brake horse power engine running one hour at its most economical point will use about six and one-half gallons of oil. This same engine, running at 50 horse power for two hours, will use about seven and one-half gallons, and running at 25 horse power for four hours will use about eight and one-half gallons. It will thus be seen that the economical range is a large part of the whole power range, a great contrast to the steam engine in this respect. In adapting a Diesel engine to a widely variable load, are, element of efficiency at different loads may be practically ignored.

The engine is started with compressed air from a storage tank, and ignition is secured during the first revolution. As soon as the engine comes up to speed, the compressed air supply is automatically cut out and the permanent air supply which injects the oil is also automatically thrown into operations. The starting and running are, in all respects, as positive, reliable and free from tricks as is the steam engine. Regulation is effected by ranging the amount of oil fuel introduced at each working stroke under control of a governor, and any number of engine units can be controlled from one governor.—*New York Evening Post.*

Air Compressor Diagrams.

The following illustrations are two diagrams taken from an air compressor driven by a cross-compound engine. The air is first received into the 19-inch cylinder and afterwards compressed to a higher



Power N.Y.

AIR COMPRESSOR DIAGRAMS.

pressure in the 11-inch cylinder. All the valves in connection with the compressor are poppet valves, with the exception of tne inlet valves at low-pressure cylinder. These are gridiron and are operated with a positive motion. You will notice at the point *A* on the diagrams taken from the low-pressure cylinder that there is a considerable rise in pressure before the piston moves. The correspondent who contributed these diagrams to "Power" would like to know what causes the rise shown by the diagrams.

Pneumatic Flue Welding Machine.

There is in operation at the Oelwein shops of the Chicago Great Western Ry., a simple but very efficient and rapid flue welding machine. The device was originated by Mr. H. A. Fergusson, assistant superintendent of motive power of the Chicago Great Western Ry., and was built at the Oelwein shops. It will be noted that the welding operation is accomplished through the medium of compressed air, the admission of the same to the cylinder at the top of the machine being effected by a foot lever. The economical feature of the device is displayed in the statement that from 75 to 80 more flues are welded per day than in the method formerly pursued at the Oelwein shops. About 300 flues are now welded per day as against 225 formerly. A weld is made complete in 4 seconds, and the output of the machine is only limited by the number of flues which can be heated in the furnace, while the work done by the apparatus is so perfect that it has been found that it is not necessary to test the flues before placing the same in locomotive boilers, nor are the flues scarfed befor welding. The ordinary water tests to which the flues are subjected after placing in the flue sheets is all that is necessary, practically no imperfect welds having been found, and there are 19,000 flues in service which have been welded on this machine, with no failure reported at the welds up to this time. The welds are so perfect that it is practically impossible to detect the point at which the two parts were joined together, even after the flue has been thoroughly cleaned and subjected to acid treatment.—*Railway and Engineering Review.*

Cylinder Sizes on Air Compressors.

A fine air compressor—a 14x14x24—was in operation in a large railroad plant, supplying air to many kinds of pneumatic tools, portable engines, car cleaning, air-brake testing, yard jacks, and a dozen other kinds of service. This air compressor was not equal to the demands made upon it for air, was often hot—that is, the air delivery was hot, and once exploded the reservoir, 40 inches by 14 feet, one end going through a brick wall and the other out into the yard. This reservoir was replaced and the compressor run afterward just as before the accident. Now remember this air compressor was a real compressor, a fine machine by a reliable builder, and when not hot was practically noiseless compared with some shop air compressors.

In making repairs on the compressor the machinist found that the air cylinder had been reduced to 12 inches by a cast-iron bushing, and that too without any provision being made for water circulation. On his recommendation that the bushing be removed he was gravely informed by those in charge that their air pressure was very high—85 pounds needed at intervals and 75 pounds continually. The steam pressure being only 85 pounds, it was impossible to enlarge the air cylinder by removing the bushing as they could not then obtain the needed 85 pounds air pressure.

It was impossible to tell these people that 85 pounds of steam in a 14-inch cylinder could compress air to 85 pounds in a 14-inch air cylinder; absurd, nonsense. So it was given up as a bad job.

There are many people who know just as much in the matter of air compressing. —F. RATTEK in *Power.*

Notes.

The current market price of liquid air in Berlin, where a company has been formed for its production and sale, is 1s. 6d. per litre, or nearly 1¾ pints.

"A man named John Baumgardner, of Manistee, Mich., went 'daffy' on the subject of compressed air last week. He was given a berth in the county jail until removed by friends."

The Trigg Granite and Marble Works, of Rockford, Ill., has recently installed air compressors and added pneumatic tools to their already large plant for cutting letters on monuments.

By "free air" is meant air at one atmospheric pressure, 14.7 pounds to the square inch. An altitude of 6,000 feet—barometer 28.83—would give an air compressor—theoretical standard 100 per cent. sea level—a comparative efficiency of 82.8 per cent.

If a volume of air at 60 pounds pressure, equivalent to 18,000 cubic feet per hour, at atmospheric pressure be passed through 1,000 feet of pipes, the loss of pressure of air for 2½ inch, 3 inch, 3½ inch pipes would be 5¾ pounds, 2 pounds, 1½ pounds, respectively.

A contract has been completed between the Great Central Railway Company and the British Pneumatic Railway Signal Company of Chippenham, Wilts, for the installation of automatic pneumatic signals through the Woodhead Tunnel, which is over three miles long.

When using compressed air don't install your piping without properly providing for drainage of condensed moisture at regular intervals in the system. The simplest method is to slightly incline the branches leading from the main line and insert drain cocks just before the hose connection is reached.

A little booklet has found its way to us, telling all about the Flinn Defferential Steam Trap, manufactured by Richard J. Flinn, West Roxbury, Mass., and sold by A. Lorge, Jr. & Co., 1019-21 Monadnock Block, Chicago. This device was described in the November issue of COMPRESSED AIR, page 2080.

The efficiency of compressed air can be greatly increased by using air-heating stoves. The efficiency of fuel consumed in heating compressed air is more than six times greater than burning the same fuel under a boiler. The efficiency of the motors is also considerably increased owing to better lubrication and to less danger from freezing up.

To determine the amount of air that can be produced by different size air cylinders, multiply the area of the cylinder by the stroke; multiply result by 2 if it is a straight line compressor; by 4 if a duplex compressor, or by 2 if a compound duplex compressor. Divide this result by 1,728, which will give the amount of air per stroke, then multiply by number of strokes per minute.

A turntable operated by a compressed air engine is in use at the West Oakland shops of the Southern Pacific Ry. The motor in use was designed at the shops. It works at 100 lbs. pressure and uses about 8½ cu. ft. of free air in turning a locomotive. The cost of the device was about $250. It is described and illustrated in *The Railway and Engineering Review* of Dec. 13.

Compressed air can be used in steam engines without any change being made in the construction of the engine if the exhaust be large. A small exhaust will have a tendency to cause the moisture in the air to freeze as it escapes from the the vent, but this may be remedied to some extent by causing the air to exhaust underneath water. A better, but more expensive method, is to reheat the air.

The Chicago & Alton has just put in a system of compressed air appliances which underlies their entire yards. The pipes are equipped with a hose fixture at each of the side tracks on which the trains are placed that are made up here. One end of the pipe is connected to a pipe at the compressed air building. This plan is now used to test the air on all trains before they are connected to an engine to be sent out on the road.

Recent important contracts awarded the air compressor department of the Chicago Pneumatic Tool Co. include five cross compound compressors, of 600 feet capacity each, for the Baltimore & Ohio Railroad; two compressors of 2,000 feet capacity each for the Pressed Steel Car Company; 2,000 foot compressor for the Kawasaki Dockyard, Japan; two 600 foot compressors for the New York Ontario & Western Railroad, and one 700 foot compressor for the signal department of the New York Central & Hudson River Railroad.

The Philadelphia Pneumatic Tool Co. has just completed the equipment of Kaiser Wilhelm's new navy yard at Kiel, Germany, with an outfit of Keller Pneu-

matic Tools. This is the latest phase of the American commercial invasion of Europe.

Looking in the opposite direction this company reports an increasing trade on the Pacific coast. Mr. O. A. Berger, the representative of the Philadelphia Company in San Francisco, has just visited the home office, bringing with him some large orders from the various ship yards, steel works, etc., on the Pacific coast.

While it is known that air can be made solid as well as liquid, up to the present comparatively few experiments have been made in this direction. A scientist recently converted a certain quantity of liquid air into a small solid mass, and on examining it found it was as transparent as clear ice and as elastic as rubber. To test its elasticity he struck it with a hammer, and the latter immediately rebounded. That solid air may prove to be of commercial value is the opinion of some scientists in Germany, but it is admitted that many more experiments will have to be made before any certainty on this point can be arrived at.

In blasting, the ground has everything to do with the grade and amount of powder used. It is not an unusual thing to drill holes to a depth of ten feet, and in some few instances to a greater depth, but as a rule a hole, say six feet, may be considered about the average. Such a hole will take about ten sticks of giant powder. In the large companies where there is room these drill holes are about two inches in diameter and the sticks of powder are one and one-quarter inch. Every one of the big companies must necessarily carry a large amount of this fearful explosive in the mines, sufficient, no doubt, should it explode all at once, to level the camp.

The Cripple Creek and Pueblo Railroad Company, of Colorado Springs, Colo., with $2,000.000 capitalization, filed articles of incorporation with the El Paso County Clerk on Dec. 10. T. B. Casey, of Boston, is president; J. R. McKay, of Chicago, treasurer. J. T. McAuley, of Chicago, is a director. The object of the company is to build a road from Cripple Creek to Pueblo over a route not to exceed thirty-three miles in length. The proposed road will reduce freight rates and secure Pueblo smelters a share of Cripple Creek business. Electricity or compressed air will furnish the motor power for the road, which will be partly an underground system.

The Fairmount Glass Works, Alexandria, Ind., has made a new application of an old principle which promises to lengthen the life of natural gas fuel and is giving marvelous results in the burning of the fluid. The process is simply the forcing of air into the well at a high pressure which mixes thoroughly with the gas before again coming to the surface, giving off a much greater heat, better combustion and a pressure amply great, where previously there was practically none. The discovery has created much interest over the gas belt.

[If this system proves effectual, as it seems to be doing at present, it will revolutionize the methods now employed in pumping and compressing gas in all sections where gas is to be found.—Ed.]

Drilling and reaming by pneumatic power may now be done in places where it is impossible to work an air motor. This is made possible by the Air Motor Auxiliary, the invention of Joseph A. Humphries, gang foreman of the Chicago Belt Railway. The auxiliary may also be successfully applied in drilling out from bolts through the frame and cylinder wall, beneath the saddle casting.

The Railway Master Mechanic, a well known authority, says: "An improvement on this device would be the application of four handles (similar to those used on an air motor) to the set screw for propelling the drill. In the present form of the device this set screw must be turned with a wrench, which is an inconvenience to the operator."

Compressors can be fitted with automatic controllers which will cause the machine to stop when the air pressure has reached a stated number of pounds per square inch, and to start it up again when the pressure has gone down to a fixed limit. In the hydraulic regulator this is accomplished by the use of two cylinders fitted with pistons, arranged tandem. One piston is subjected to air pressure, the other to water. When the air pressure is

greater than the water pressure it forces the water cylinder piston to close the gate on the pipe line, and, the power being cut off, the compressor stops. The air being used in the mine causes the pressure to decrease until the water pressure overcomes it, when the gate is opened and the compressor again starts up. Supplied with a device of this description, a compressor requires little attention.

It is reported that a certain man, named Count Ravelli, is determined not to meet a watery grave as did so many of the other members of his family. Two sisters, two uncles, a brother and the count's father have all been drowned, and he therefore has invented a remarkable suit of pneumatic garments which he wears all the time when in the vicinity of water. He has a hat which in itself is a life preserver. It looks like an ordinary hat, but by means of a tiny valve, generally out of sight, it can be quickly inflated when it will float like a cork. Not only the hat, but everything worn by the count—his coat, vest, even his shoes and umbrella—is inflatable. Whenever the count sees water he blows into one or more tubes and instantly he swells up to enormous proportions and it would be impossible for him to drown. "Isn't he a funny man."

The street car company of Salt Lake City, Utah, has responded quickly to the popular demand for cleaner street car. The air compressor has recently been received at the factory, and it will be installed at the car barn as quickly as the work can be done. The machine cost $2,100. It will be operated by electricity and will work like the compressors used in cleaning railroad coaches.

The officials of the street car company hold that the city authorities are largely to blame for the dirty street cars, and that they could do very much toward keeping them clean by cleaning the street crossings. It is urged that the street sweeper could be used to very good effect in cleaning the crossings in the business part of the city. With the mud on the crossings as deep as it is a great part of the time, Superintendent Read is not sanguine of keeping the cars very clean even with the greatest care.

Perhaps the most unspeakably horrible and atrocious thing which it ever came in the line of our duty to speak of, was the killing of a thirteen-year-old boy by his young shopmates at the American Locomotive Works, South Paterson, N. J., on December 4. The lad was a new employee and was being "initiated," as is a quite common practice, under which the subject is made the victim of any prank the moment may suggest. As in any such establishment, there is a constant supply of compressed air usually maintained at a pressure of 80 to 100 pounds with attached hose and nozzles for blowing away dust and chips and other uses. The boys applied the hose to the body of the victim and turned on the pressure, with the result of rupturing the intestines, and the boy died after lingering in agony for two or three hours. It would seem to be impossible and useless to comment upon the occurrence.

A neat application of compressed air is used at the Toronto Junction shops of the Canadian Pacific, in connection with the wheel press. When the axle is brought to the press, instead of being hung from the horizontal beam of the machine, it is supported on what is practically a permanently placed small air jack, situated two or three feet in front of the press. The axle can be raised to the required height by the operator pressing his foot on a button in the floor very much like that by which a motorman on a street car rings his gong. When the axle is upon the air jack, the wheels are rolled to position and entered. Two iron rack plates on the flood allow the wheels to easily slip in toward the wheel seats when urged thither by pinch bars, whose points engage with the teeth of the rack. When the wheels have been pushed in a sufficient distance by hand, the air jack is lowered and the wheels and axle roll forward to the press, where the operation is completed.

The dingy walls and pillars of the east front of the treasury building at Washington, D. C., have for a long time been the despair of the officials of the department who are charged with the care of the structure, says the *New York Times*. How to clean them has been a problem for many years. Recently Chief Clerk Hill thought of using the com-

pressed air sand blast, and wrote to a Chicago firm that has patents on the process. A few days ago the building was subjected to the new method of cleaning, and the results are wholly satisfactory.

The men who manipulate the machine wear a long hood to keep the particles of sand and grit from the granite out of their eyes and lungs, and with a small engine go over the huge pillars and stones slowly in the same fashion that an atomizer paint machine works. The sand blasts removes the dirt and a thin layer of stone, and leaves the pillars looking practically as well as new.

The Chicago Pneumatic Tool Company, Chicago, are mailing to the trade a four-page circular, designated as Special Circular No. 32, attractively designed in black and red on enamel paper, illustrating the Tynan Patent Annealer and the Tynan Rivet Heating Forge. The company has secured the entire control of these devices and will be the exclusive manufacturers of same in the future. The Annealer and Rivet Forge fit in very nicely with the line of pneumatic appliances which the company manufacture, as they operate by compressed air, using crude oil as a fuel. They are designed for the various classes of repair work incident to shipyards, railroad shops, etc., and repeated demonstrations have proven them to be far superior for this class of work to the various machines of similar character on the market. Both machines are light in weight and therefore easily removed from place to place—an important feature in the class of work for which they are adapted.

H. K. Porter Company, Pittsburgh, builders of light locomotives, report very active business conditions. They have just completed two 24-in. gauge compressed air mine locomotives for a large lead company in Missouri; also a heavy compressed air locomotive for the mines of the Keystone Coal and Coke Company, of Pennsylvania, and additional air locomotives are now building for the McCormick Harvesting Machine Company, to be used at the Chicago works. Another order is being filled for the Ceneral Coal and Iron Company, Alabama. Contracts have recently been closed for similar machines, including the equipment of the Dominion Iron and Steel Company, Sidney, Cape Breton. The shops are now engaged in building a number of steam mine locomotives for West Virginia and Pennsylvania, also a number of logging locomotives for the West and South. Lately there has been an unusual demand for this machinery for steel works and contractors, for switching locomotives, and the books show a large number of orders for export to Mexico, the West Indies, Japan and South America.

A scheme is being promoted in Paris for constructing a system of subterranean pneumatic conduits for the rapid transportation of mail matter and parcel freight and express. The proposition has been brought to the notice of the government, and official trials will be made of models. The system employs electricity as its motive power, and its inventors represent that they can transport cars weighing a ton over any given distance at a speed of 160 miles an hour. The system is styled the "electric postal service." A metal duct is to be constructed, of a width not exceeding 30 ins., which will be wide enough for a double track to accommodate trains going in opposite directions. The cars would be simply sheet iron cases, supported on two or four axles, and carrying the electric motors. The central compartment of each "car," measuring about 20 cu. ft., would be reserved for freight. The total length of each vehicle would be about 22 ft., but it would not exceed 20 ins. in height. To counteract the resistance of the air—naturally of great force in view of the excessive speed attained by the vehicle—the front and rear of each car would be equipped with wind cutters in parabolic form.

The Pneumatic Signal Co., Broad-Exchange, Bldg., New York City, with western offices in the Monadnock Bldg., Chicago, has published an illustrated pamphlet on the "EZ-Pipe" carrier. The construction of this carrier makes it of universal application, and it is unnecessary to carry any number of ways or any special bolts for tying the same together. The carrier stand 27 E. Z. has a thin lip,

forming a part of the opening at the top for the purpose of tying the two uprights together with a pin. In installing this form of carrier, the stands are fastened to the foundation with lag screws, the top roller is slipped on to the pin, and this pin with top roller is dropped into the top of the carrier and quickly secured in this position by inserting a cotter. The addition or reduction of a lead of pipe can be accomplished quickly and without the necessity of discarding any of the note that nearly 90 per cent. of all the hot boxes reported are driving boxes. The question naturally arises, why? Taking a modern freight engine, for instance, we find the projected area of the engine truck journals to be 63 sq. ins., and the weight per sq. in. 142.8 lbs., while that of the driving journal is 112 sq. ins., carrying 194 lbs. per sq. in. The travel of engine truck journals, we find, is 1052 ft., while that of the driving journals is 927 ft. per mile.

The thousands of people who pass the big Traction skyscraper, in course of erection at Fifth and Walnut streets, Cincinnati, Ohio, marvel at the rapidity of the work of construction. Modern machinery and equipment make possible the putting up of one of these structures as rapidly as if it were all masonry..

Immense boom cranes swing the iron pillars to the points where they are wanted. A "stiff-leg" derrick then lifts the column to the top of the one beneath it, and intercepting flanges act like a cleat to receive it. The column is bolted on by the iron workers, and they immediately start after another column, while the riveters follow them up.

There is a man to heat the rivets and one to pass them. Another man operates the "woodpecker," as the compressed air riveting machine is called. It makes a noise not much unlike that of a great woodpecker hammering away at a tree, there is a succession of hard raps, and in about seven seconds, often less, the rivet is clinched. The operator of the "woodpecker" can carry his machine to any part of the structure, as the instrument is light and portable, and the air is fed through a long line of hose. The air-compressor is operated by an engine in the cellar. The granite layers, with their "facing," follow the riveters, and, while bricklayers back up the facing, workmen are making ready for the flooring. A hoisting machine dispenses with hodcarriers.

The great Consolidated Pneumatic Tool Trust, which recently amalgamated the leading manufacturing firms in this line, has decided to commence operations in Scotland on a very large scale.

Up to now the making of pneumatic tools has been almost wholly an American industry. Within five years a trade has been built up there employing 5,000 workmen. The British factories, which are to manufacture for all Europe and for the British colonies, will, as a beginning, employ 4,000 men and spend £300,000 a year on wages.

Aberdeenshire has been chosen as the centre for the new factories, with the little town of Fraserburg as the headquarters. The experiment of opening works so far from the established centers of trade has been resolved on for novel reasons.

"We have determined to start there," says Mr. Maconochie, M. P., Chairman of the British Board of Directors, "because of the climate, the kind of labor to be had, and the remoteness from towns. If you have a man in training for athletics you put him in the surroundings where he can develop his best. So it should be with keeping your workmen in good form, if you began on a rational basis. Everything is against the man in a big city. He has a hundred things to distract and tempt him; he breathes vitiated air, rent is high, and many expenses accumulate. I am convinced that the hope of much manufacturing enterprise in the future will lie in getting the works away from cities."

The work of erecting the factories will be begun in Fraserburg in January. The plans are being sent from America. On a basis of granite there will be erected buildings of steel framework with the sides as as far as possible of glass.

"American business methods will be introduced," Mr. Maconochie adds, "and American managers will teach their ways. With American organization and British labor you have the finest industrial combination possible."

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz.: all communications should be written on one side of the paper only; they should be short and to the point.

Canton, Stark Co., Ohio, Dec. 27, 1902.

Sirs: I have heard of the excellent teachings through your journal on the application of compressed air. Please send me several sample copies of your journal and let your subscription price be known. Could you furnish me any books treating on compressed air? Yours truly,

GEORGE E. SMITH.

One of our readers writes us as follows:

Sirs: I am a subscriber to both COMPRESSED AIR and the *Cyclopedia of Compressed Air Information*. Can you find the first two volumes of COMPRESSED AIR for me? I was foolish enough not to save them, and now would give anything within reason to get them, bound or unbound. A. D. FOOTE, Supt. North Star Mines, Grass Valley, Cal.

(Correspondence is solicited on the above subject.)

Index for Vol. II. is very much wanted by COMPRESSED AIR, who will be glad to purchase same if it be possible to obtain it.

Sirs: In your December issue, there is an error in statement, in regard to the d'Auria Air Compressor, which I would like to have corrected if possible—which is, that the machine is built by the I. P. Morris Co., the fact being that I built the machine described in my paper read before the American Institute of Mining Engineers, which you so kindly copied. As I was not writing an advertisement, I naturally refrained from stating that I was the builder.

If the correspondent of the *American Machinist* will apply to the d'Auria Pumping Engine Company, No. 941 Drexel Building, Philadelphia, he will probably be enlightened more fully as to the merits of the machine. Yours very truly,

HENRY G. MORRIS.

Sirs: Can you refer us to any data or papers on separators, mechanical or chemical, for removing water from compressed air?

Thanking you in advance, we are,

Yours truly,

BORTON & TIERNEY CO.

In answer to your letter of Dec. 17, asking if we have any data on the subject of separators, mechanical or chemical, for removing water from compressed air, we are sending you under a seperate cover a copy of COMPRESSED AIR for November, 1902, on page 2080, of which you will find a description of a form of separator which we understand is well adapted for compressed air mains.

You will also find on page 2082 a description of a washer, which will prove of service in cases where dust and oil must be removed. We would also suggest that you correspond with some of our advertisers who manufacture compressed air machinery, as they can probably quote you on special devices for removing the water from compressed air.—ED.

Western Tube Co., Kewanee, Ill., Jan 1, 1903.

COMPRESSED AIR:

We note in your issue of December, you show on page 2104, a pneumatic sand rammer and we should like to know from whom we can get prices and other information in regard to one of these complete, which you specify as weighing about 20 pounds.

We would like to have the information promptly and would consider it a favor if you would let us have an early reply.

Yours truly,

WESTERN TUBE COMPANY,

Purchasing Agent.

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U. S. PATENTS GRANTED NOV. 1902

Specially prepared for COMPRESSED AIR.

712,478. PNEUMATIC-DESPATCH-TUBE SYSTEM. Thomas Bemis, Indianapolis, Ind. Filed May 17, 1902. Serial No. 107,799.

A pneumatic-despatch-tube system, the combination with a pressure-maintaining device, of a non-carrier-receiving trunk-line pipe leading thereto, a plurality of overlapping independent pipe-lines leading into said trunk-line at different points in its length, and cut-outs arranged between and connecting adjacent overlapping portions of independent pipe-lines, each of said cut-outs being provided with means by which carriers may be transferred from one pipe-line to another.

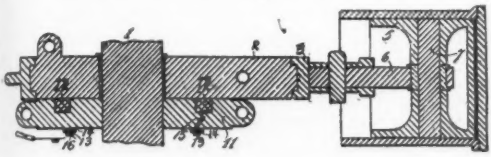
712,479. PNEUMATIC-DESPATCH-TUBE SYSTEM. Thomas Bemis, Indianapolis, Ind. Filed May 17, 1902. Serial No. 107,800.

A pneumatic-despatch-tube system, the combination with a suction device, of a loop-circuit pipe-line, a supplemental-circuit pipe-line, one end of said supplemental pipe-line being connected to the first arm of the loop, and the other end of the supplemental pipe-line being connected to the second arm of the loop, a cut-out arranged at the point of junction between the first arm of the loop-circuit and the beginning of the supplemental circuit, said cut-out being provided with means for allowing the passage of a carrier therethrough from one circuit to another, a cut-out arranged at the point of junction between the supplemental circuit and the second arm of the loop-circuit and provided with means for allowing the transfer of a carrier from the supplemental circuit to the loop-circuit, and an air-passage between the supplemental pipe-line and the suction device.

712,508. AIR-COMPRESSOR FOR AIR-BRAKES. Burt J. Denman, Toledo, Ohio, assignor to John R. B. Ransom, Toledo, Ohio. Filed Nov. 7, 1901. Serial No. 81,384.

An air-compressor, the combination of an axle, a cam loosely mounted upon said axle and provided with a cam-strap, a cylinder, a piston connected to said cam-strap, an electromagnetic disk fixed upon the axle and adapted for direct engagement with the loosely-mounted cam, and means for controlling the electric circuit in said disk to cause it to directly engage or disengage said cam.

In combination, an air-compressor, an axle, a cam loosely mounted upon the axle, a cam-strap in engagement with said cam and connected to the air-compressor, a disk fixedly



mounted upon said axle contiguous to the loose cam, an electric coil carried by said disk, a collecting-ring mounted upon and insulated from the disk, connections between the collecting-ring and the coil, and a make-and-break device in circuit with said coil for controlling the electric circuit in said coil.

712,833. ENGINE-BRAKE. Edward Y. Moore, Cleveland, Ohio, assignor, by mesne assignment, to Chicago Pneumatic Tool Company, a Corporation of New Jersey. Filed Oct. 14, 1901. Serial No. 78,542.

An engine having a crank-pin crank and crank-shaft combined with an extra disk journaled axially with the crank-shaft and loosely engaging the crank-pin, and means for moving said disk parallel with the axis of the crank-shaft to cause braking, substantially as described.

The combination with a pneumatic motor, of a break and a pneumatic mechanism for operating it, said brake including a non-rotable member and a co-operating rotatable disk loosely engaging a crank-pin of the motor and located axially with the crank-shaft and movable longitudinally thereof to apply or relieve the brake, substantially as described.

712,843. PNEUMATIC SUGAR-CANE CUTTER. Ralph H. Paul, Brisbane, Queensland, Australia. Filed Aug. 17, 1901. Serial No. 72,394.

A pneumatic sugar-cane cutter, a cylinder, a reciprocating piston therein, a sugar-cane cutter operated by the impacts of said piston, and means pivotally carried by said cylinder for enabling the latter to be secured to and supported from the arm of the user.

A pneumatic sugar-cane cutter, a cylinder, a cutter-holder mounted in the front end thereof, a sugar-cane cutter adapted to be inserted into said holder, a reciprocating piston in said cylinder, a handle on said cylinder, and means pivotally carried by the latter for enabling the cylinder to be supported from the arm of the user

712,902. PNEUMATIC STACKER FOR THRESHING-MACHINES. Oscar O. Bodvig, Velva, N. D. Filed May 13, 1902. Serial No. 107,156.

The combination with a threshing-machine, of a pneumatic stacker mounted thereon and comprising a plurality of sections, one of which is capable of being revolved and moved longitudinally, the movable section having its forward portion hinged to swing in a vertical plane, a spring for controlling said hinged portion, means for revolving the section, and means for moving the section longitudinally.

The combination with a threshing-machine, of a pneumatic stacker mounted thereon and comprising a plurality of sections, one of which is capable of being revolved and moved longitudinally, means for revolving the section, an adjusting-rod for moving the section longitudinally, and means for connecting the adjusting-rod to the movable section whereby it may be revolved independent of the adjusting-rod.

712,915. AIR-BRAKE SIGNALING AND RELEASING DEVICE. Frank H. Dukesmith, Charlestown, W. Va., assignor of one-half to Benjamin F. Ackerman, Palestine, Tex. Filed June 6, 1902. Serial No. 110,490.

An air-brake signaling and releasing device comprising a cylinder arranged at one end for connection with the brake-cylinder, a piston operating in said cylinder and arranged to be actuated by the pressure from the brake-cylinder, a spring for readjusting the said piston to normal position, a hollow piston-rod extending from said piston and arranged to receive pressure from the brake-cylinder, a valve in the piston-rod, and a signal carried thereby substantially as set forth.

713,366. INTERNAL-COMBUSTION ENGINE. Henning F. Wallmann, Chicago, Ill., assignor to the Wallmann Engine Company, a Corporation of Illinois. Filed Feb. 3, 1900. Serial No. 3,842.

An internal-combustion engine, the combination with a combustion-cylinder, of means for supplying a body of compressed air thereto for the combustion of the fuel, means for subsequently injecting a charge of fuel at a

higher pressure into said body of compressed air and for firing the mixture, and means for introducing into the hot expanding products of combustion in the combustion-cylinder another body of compressed air commingled with a spray of water or steam, substantially as described.

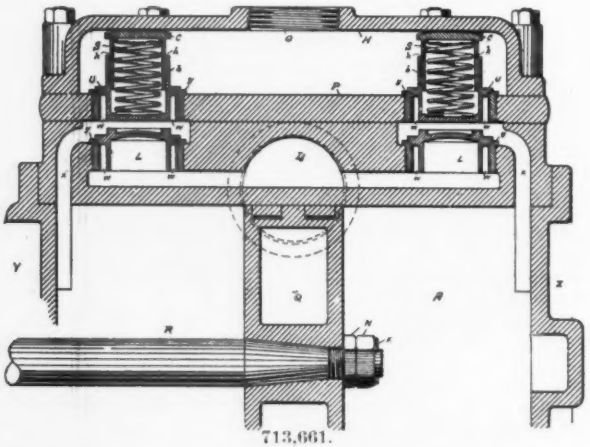
713,367. INTERNAL-COMBUSTION ENGINE. Henning F. Wallmann, Chicago, Ill., assignor to the Wallmann Engine Company, a Corporation of Illinois. Filed Mar. 21, 1900. Serial No. 9,530.

An oil-engine, the combination with a combustion-cylinder having an air-inlet valve, a fuel-inlet valve, and an exhaust-valve, all located in the head of the cylinder of an air-compressor which delivers compressed air to the combustion-cylinder past said air-inlet valve, the initial portion of said compressed air serving as a scavenging-blast and the remainder forming part of the next combustible charge, a second air-compressor whose delivery is connected to the casing of the fuel-inlet valve, and a fuel-pump whose delivery-pipe taps the air-duct between the discharge-port of said second air-compressor and the casing of the fuel-inlet valve, substantially as set forth.

713,631. DISCHARGE-VALVE FOR COMPRESSORS. Frederick W. Gordon, Hartford, Conn. Filed Mar. 17, 1902. Serial No. 98,543.

In discharge-valves for compressors, the combination, substantially as set forth, with a compressor-cylinder, compressor-piston, discharge-chamber, and discharge-valve opening to the discharge-chamber, of a piston and cylinder disposed at the back of the discharge-valve and arranged to detract from the area thereof subject to discharge-pressure, a tappet projecting into the compressor-cylinder and adapted to be engaged by the compressor-piston as it nears the end of its compressive stroke, and connections between said tappet and the valve whereby the movement of the tappet under the influence of the compressor piston causes the practical closure of the valve.

713,661. AIR-COMPRESSOR VALVE. Foster M. Metcalf, Battlecreek, Mich., assignor to American Steam Pump Company, Battlecreek, Mich. Filed Apr. 28, 1902. Serial No. 105,119.



713,661.

An air-compressor valve having an extended sleeve, a cushion-cap embraced within the same, and in sliding engagement therewith, an internal spring acting to separate the valve and cap, and the cap having radial holes communicating with the interior thereof, substantially as shown and described.

713,687. BLOWING-ENGINE. Cyrus Robinson, Pittsburg, Pa., assignor to the Westinghouse Machine Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed Oct. 19, 1899. Serial No. 734,114.

An air-compressor, the combination of a stationary cylinder, outlet-valve for controll-

ing the escape of compressed air and adapted to yield to the air, springs for holding said valves closed against the pressure of the air, a piston adapted to reciprocate in said stationary cylinder, a piston-rod connected to said piston, power mechanism connected to the said piston-rod to drive it, said rod being provided with an air-duct, a valve in said air-duct, a lever for moving the said valve carried by and movable with the piston-rod, and means for moving said lever independently of the movement of the piston-rod.

713,739. PNEUMATIC STACKER. Chester Bradford, Indianapolis, Ind., assignor to the Indiana Manufacturing Company, Indianapolis, Ind., a Corporation of West Virginia. Filed May 17, 1902. Serial No. 107,798.

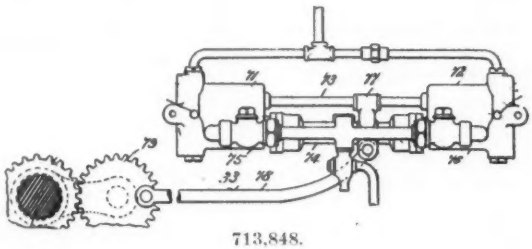
The combination, in a pneumatic stacker, of the delivery-duct, a turn-table carrying the same, a curved rack on said turn-table, a mutilated gear adapted to engage with said rack and thus actuate said turn-table, a mechanism for driving said mutilated gear, and means for reversing said mechanism at the end of a predetermined travel in each direction and arranged to operate after the mutilated gear has passed out of engagement with said curved rack, whereby the latter is permitted to pause at each end of its travel before starting on its return movement.

713,787. PNEUMATIC STACKER. William McKone, Neepawa, Canada, assignor of five-sixths to Daniel Hamilton, William Pringle Johnston, George Arthur Dinwoody, Horatio F. Forrest, and James Henry Howden, Neepawa, Manitoba, Canada. Filed June 13, 1902. Serial No. 111,539.

713,834. AIR-VALVE FOR SHIPS. Theodorus S. Bailey, Elizabeth, N. J. Filed Dec. 28, 1901. Serial No. 87,544.

A device of the character described, a casing having a passage therethrough for air, a pair of valve-seats in said casing, a pair of independent valves for said seats, means for automatically closing one valve against its seat when water attempts to pass in one direction, and similar means for closing the other valve against its seat when water attempts to pass in the opposite direction, both valves normally remaining open for the free passage of air.

713,848. AIR-COMPRESSING DEVICE. James H. Bullard, Springfield, Mass., assignor to the Overman Automobile Company, Chicopee, Mass., a Corporation. Filed Nov. 25, 1901. Serial No. 83,593.



713,848.

A pump consisting of a cylinder, a valve-chest therefor, an induction and an eduction pipe in said chest, a check-valve in the latter for each of said pipes and opening in the same direction, a single port for the cylinder located between the check-valves and serving both for an induction and an eduction port; a passage outside the valve-chest communicating with opposite ends of the latter, and in communication only with the eduction-pipe, and an expansible and retractable sack in proximity to the check-valve for the induction-pipe, adapted to be inflated by back pressure from the eduction-pipe whereby an excess of pressure in the latter will effect the lifting of the check-valve in the induction-pipe from its seat, to render the pump ineffective.

713,924. PNEUMATIC-DESPATCH SYSTEM. Kenneth E. Stuart, Philadelphia, Pa. Filed Jan. 27, 1902. Renewed Oct. 22, 1902. Serial No. 128,241.

In a pneumatic-despatch system the combination with a despatch-tube of a movable barrier extending into the tube in normal position to be struck by and arrest the motion of an advancing carrier, a latching device arranged to lock the carrier in normal position or in the alternative to have it unlocked and free to move out of the way of an impacting carrier and selective latch-actuating mechanism also extending into the tube in the path of the advancing carriers to be acted upon by selective carrier-heads.

In an air-brake system for street-cars, the combination of a brake-cylinder provided with air connections, a piston mounted in said cylinder, a spring bearing on said piston, a piston-rod passing through both heads of said cylinder, a brake-beam bearing two shoes set to engage two of the wheels of the car, a connecting-rod connected to said brake-beam and to one end of said piston-rod, a lever connected to the other end of said piston-rod, a brake-beam bearing brake-shoes, and a connecting-rod connecting said lever and said last-mentioned brake-beam.

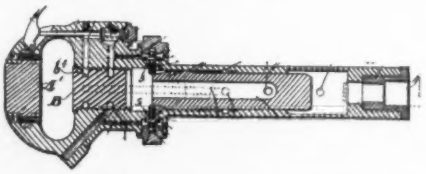
714,273. AIR OR VACUUM MOTOR. Max Arndt, Aix-la-Chapelle, Germany. Filed Jan. 20, 1899. Serial No. 702,855.

A motor, the combination with a smoke-stack of a bell dipping in a sealing liquid and suspended on a counterweighted lever, a main pipe discharging into the interior of the bell and connected with the smoke-stack by a branch pipe of a comparatively small size, a valve to temporarily open and close the main pipe and a controlling-lever actuated by the said counterweighted lever to control the valve.

714,295. RELIEF-VALVE FOR AIR-COMPRESSORS. Arthur Giesler, Dayton, Ohio, assignor to the Stillwell-Bierce & Smith-Vaile Company, Dayton, Ohio, a Corporation of New Jersey. Filed Mar. 27, 1901. Serial No. 53,018.

An air-compressor, two cylindrical valve-casings connected by an air-channel and located one at each end of the compressor-cylinder, ports leading from the lower ends of the casings to the corresponding ends of the cylinder, valves in the casings, commanding the ports and opening outwardly, springs for opening said valves, pistons upon the valve-stems, diaphragms secured to the pistons and to the cylindrical casings, a chamber in the upper ends of said casings above the diaphragms, a valve-casing located at the side of the compressor, and containing two oppositely-facing valve-seats, passages through said seats connecting the ends of the casing with the space between the seats, valves for the passages so arranged that one is seated as the other is unseated, an air-vent in one end of the casing, means for holding the valve commanding the vent normally seated, and the other one open, a pipe connecting the compressor-reservoir with the closed end of the casing, and pipes connecting the space between the valves with the chambers above the diaphragms.

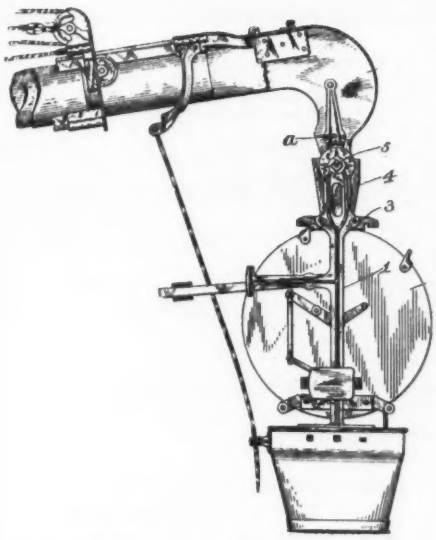
714,321. PNEUMATIC HAMMER. John T. McGrath, Fort Gratiot, Mich. Filed Jan. 11, 1902. Serial No. 89,345.



A pneumatic hammer, the combination with a casing having a supply-passage for air provided with a main controlling-valve, said casing having ports for admitting air in rear of the piston, check-valves controlling said ports and having stems projecting into the casing, a piston within the casing having inclines for contacting with said stems to raise the valves from their seats to admit air and propel the piston, means for admitting air to the opposite side of the piston to return it to initial position, and means whereby the air is exhausted from the chamber, substantially as described.

714,358. PNEUMATIC ELEVATOR AND WEIGHER. Chester Bradford and Ridgely B. Hilleary, Indianapolis, Ind. Filed Dec. 18,1901. Serial No. 86,341.

The combination, in a pneumatic elevator and weigher, with a separating-head changeable in its position, and a weighing-receptacle located therebelow, of an intermediate hopper arranged between said separating-head and said weighing-receptacle and held in substantially unvarying relation to said recep-



tacle and adapted to receive the discharge from said separating-head and guide it into said weighing-receptacle.

714,497. RAILWAY ELECTRIC-MOTOR-COOLING SYSTEM. Cyprien O. Mailloux and William C. Gotshall, New York, N. Y. Filed Aug. 26, 1902. Serial No. 121,077.

The combination with an electric-railway motor, of a source of compressed air or gas upon the car or train of cars propelled by said motor and means for releasing and discharging the air into or upon the motor to keep the temperature of the same down by the refrigerating or cooling effect due to expansion of the air.

714,631. TRUING DEVICE FOR TRIPLE CYLINDERS OF AIR-BRAKES. Edwin M. Barnes, Sacramento, Cal., assignor of one-half to Robert Graham and Edgar R. M. Pierce, Sacramento, Cal. Filed July 23, 1902. Serial No. 116,750.

A device for truing cylinders of triple valves of air-brakes, the combination of a removable bearing arranged to fit within the slide-valve seat, means for fixedly clamping and centering said bearing in said seat, a device attached to said bearing having an internal thread, a cutter-stem having a threaded end working in said internal thread, a cutter-holder carried by said stem, and cutters carried by said holder.

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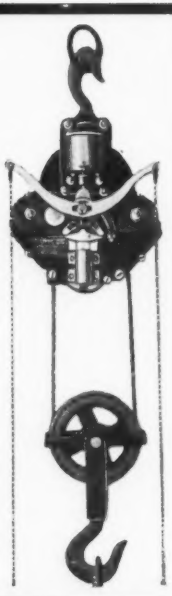

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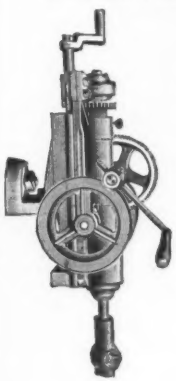

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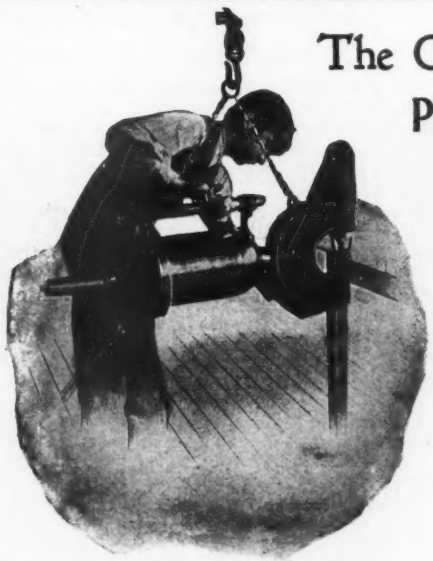

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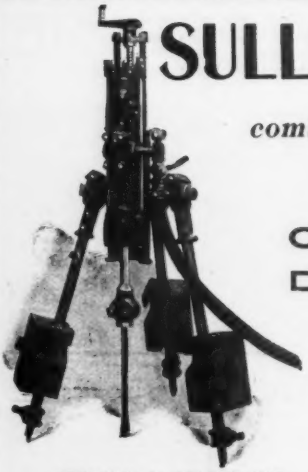

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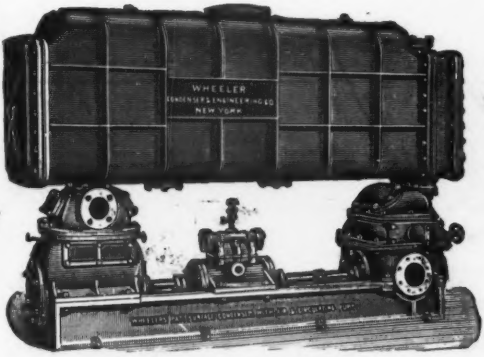

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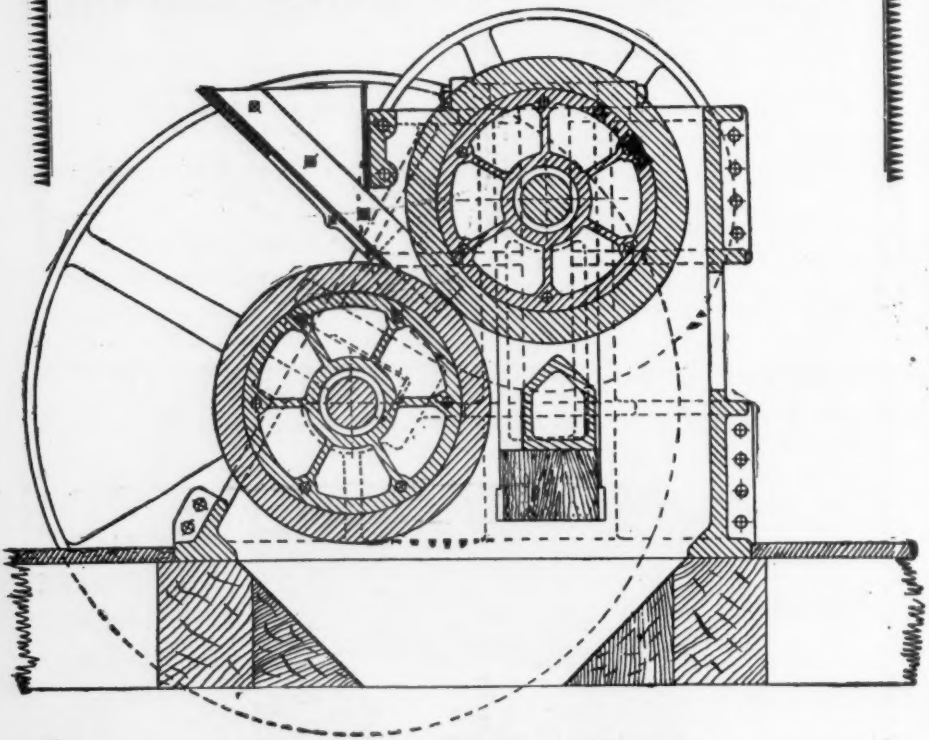

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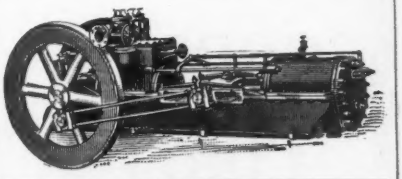

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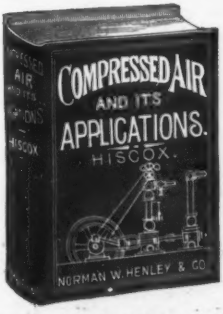

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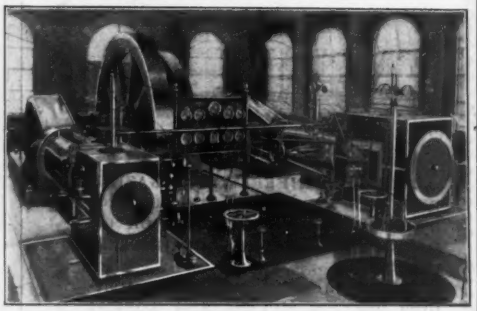

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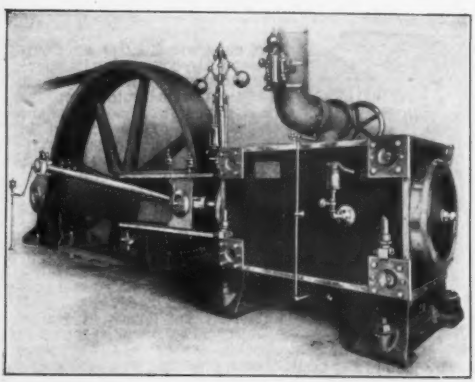

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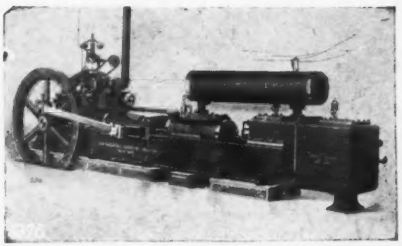

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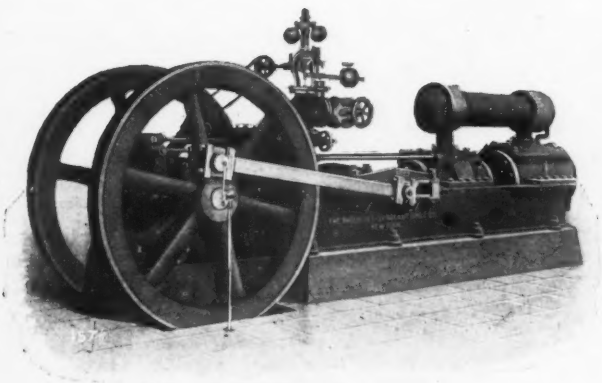

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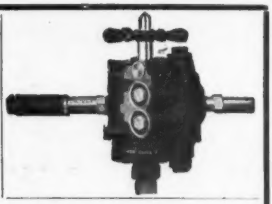

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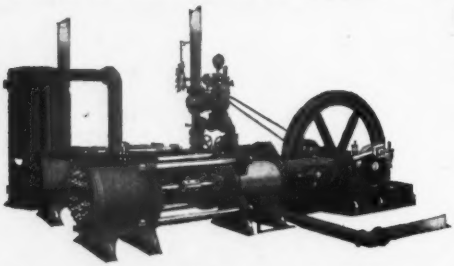

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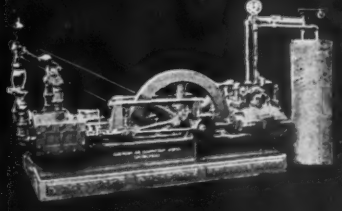

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